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CX10/150	150	10	0·1	CX5/150	150	5	0·1
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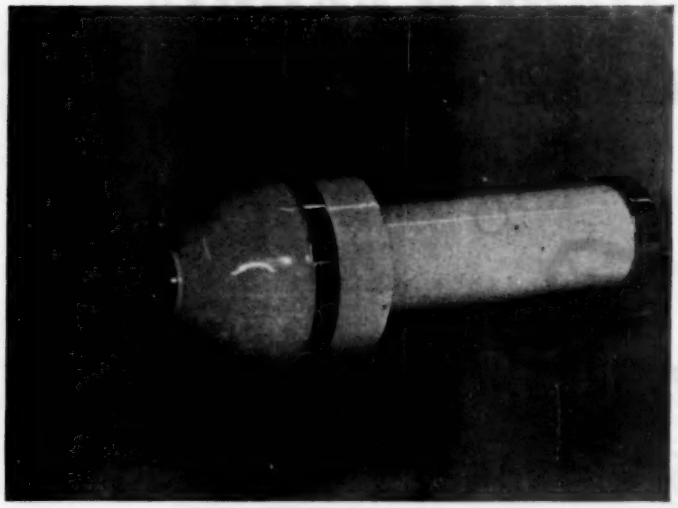

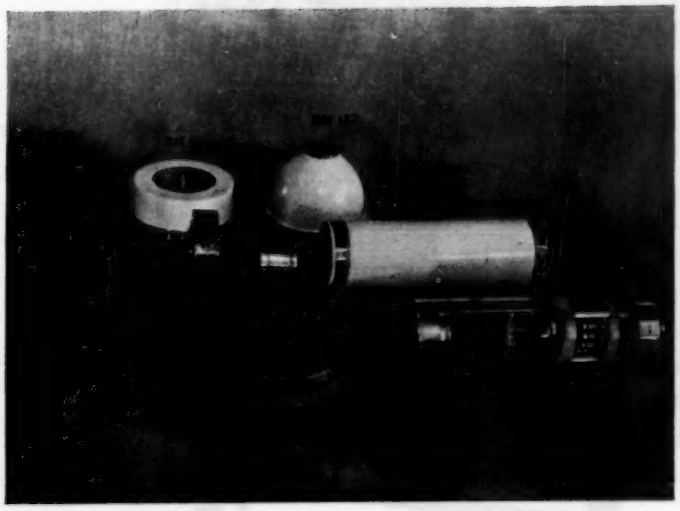

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PHYSICS ABSTRACTS

Volume 63 JULY 1960 Number 751

MATHEMATICS

518 : 681.142

8465 "LĪLĀVATĪ" — A NEW ANALOGUE COMPUTER FOR SOLVING LINEAR SIMULTANEOUS EQUATIONS AND RELATED PROBLEMS. I. GENERAL PRINCIPLES AND DESIGN OF MODEL I. G.N.Ramachandran and E.V.Krishnamurthy.
Proc. Indian Acad. Sci. A, Vol. 48, No. 3, 152-64 (Sept., 1958).

Describes a resistive passive-network computer, its operation and application. K.C.Garner

518 : 550.3 : 621.317.76

PHOTOMECHANICAL PULSE FREQUENCY ANALYSER. See Abstr. 8350

518.5 : 536.48 : 621.374.32

RELAXATION TIMES IN LEAD FILM, SUPERCONDUCTIVE, STORAGE ELEMENTS. See Abstr. 7035

519

8466 STUDY OF THE FIRST TERMS IN THE SERIES DEVELOPMENT OF A TOTALLY SYMMETRIC FUNCTION OF AN ANGULAR MOMENTUM [OPERATOR] IN A PROBLEM WITH TETRAHEDRAL SYMMETRY. J.Moret-Bailly.
C.R. Acad. Sci. (Paris), Vol. 250, No. 7, 1198-9 (Feb. 15, 1960). In French.

Shows how to find the matrix elements, with respect to a set forming a basis of an irreducible representation of T_d, of the irreducible fourth-order tensors of angular momentum components involved in this series development. J.Hawgood

519

8467 ON THE STABILITY OF RANDOM SYSTEMS AND THE STABILIZATION OF DETERMINISTIC SYSTEMS WITH RANDOM NOISE. J.C.Samuels.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 594-601 (May, 1960).

A general theory of mean square stability of random linear systems is developed when several system parameters vary as white noise stochastic processes. It is found that stability in mean square is determined from the character of the roots of a determinantal equation involving the Fourier transforms of double products of the weighting functions of the "average" system and the spectral densities of the parameter processes. The general theory is applied to the mean-square stability of an L.C.R. circuit in which the resistance and capacitance have purely random fluctuations. In the course of the study, a new type of dynamic stability is predicted namely, the possibility of stabilizing unstable deterministic systems with random noise. Preliminary experimental studies appear to confirm this theoretical prediction.

519 : 539.2 : 548.7

TO FIT A PLANE TO A SET OF POINTS BY LEAST SQUARES. See Abstr. 8203

ASTROPHYSICS

523 : 530.12

8468 ON THE RELATIVISTIC INTERPRETATION OF ASTRONOMICAL OBSERVATIONS. C.B.Mast and J.Strathdee.
Proc. Roy. Soc. A, Vol. 252, 476-87 (Oct. 27, 1959).

The basic ideas of apparent motion are formulated within the framework of general relativity theory. This requires the introduction of a dynamically meaningful frame of reference. A differential equation characterizing motion relative to this frame in a space of arbitrary curvature is formulated and its solutions for nearly flat space-time are obtained. These solutions are compared with the results of classical and special relativistic theory.

523.11

8469 ON A REVISED TABLE OF ABUNDANCES OF ELEMENTS BY A.G.W.CAMERON. G.R.Burbidge.
A REPLY TO G.R.BURBIDGE. A.G.W.Cameron.
Astrophys. J., Vol. 131, No. 2, 519-21, 521-3 (March, 1960).

The principal point at issue is the relative importance of nuclear physics, chemistry and astrophysics in establishing a table of abundances. Burbidge gives reasons for objecting to Cameron's contention (Abstr. 6442 of 1959) that it is reasonable to adjust Suess and Urey's table (Abstr. 927 of 1957) when predictions based on a nuclear physical theory disagree with this. These objections are considered by Cameron in the second note. A particular point discussed is the abundance of lead in the chondrites.

G.A.Chisnall

523.14

8470 DENSITY AND VELOCITY DISTRIBUTION OF THE INTERSTELLAR GAS. H.C. van de Hulst.
Rev. mod. Phys., Vol. 30, No. 3, 913-21, 922 (July, 1958).

This paper reviews knowledge about the interstellar gas derived from both 21 cm and optical studies. There is fair agreement between the positions of neutral hydrogen spiral arms, associations and Cepheids. The velocity dispersion of hydrogen observed within a spiral arm is due to relative cloud motions (r.m.s. velocity = 7 km/sec) and motion within clouds (r.m.s. velocity = 2 km/sec). Estimates of the size of interstellar clouds range from 10 to 100 parsecs. However fine structure is observed down to 0.001 parsecs. The density range of clouds is in the range 1-10 hydrogen atoms cm^{-3}. R.D.Davies

523.16

8471 THE SOURCE OF RADIATION FROM JUPITER AT DECIMETER WAVELENGTHS. G.B.Field.
J. geophys. Res., Vol. 64, No. 9, 1169-77 (Sept., 1959).

The flux of radiation from Jupiter at decimeter wavelengths is relatively large, and is approximately independent of wavelength in the interval from 3 cm to 68 cm. Four possible sources of this radiation are proposed and discussed quantitatively. It is concluded that the radiation does not originate in Jupiter's ionosphere, nor does it seem likely that it comes from its atmosphere. It is not due to synchrotron radiation by cosmic-ray electrons. On the other hand, electrons from the sun which are trapped in Jupiter's magnetic field, may very well be the source. Observations for testing whether this possibility is correct are discussed.

523.16

8472 THE IONOSPHERE OF JUPITER. H.Rishbeth.
Austral. J. Phys., Vol. 12, No. 4, 466-8 (Dec., 1959).

A short note indicating that sufficient ionization may be produced in the ionosphere of Jupiter by solar radiation to account for the observed radio frequency emissions on the assumption that they

arise in plasma oscillations. The required electron density will only be attained if the recombination coefficient is low and it is suggested that this may be so due to the absence of dissociative recombination in the Jovian ionosphere which is estimated to lie a few hundred km above the visible clouds. C.Hazard

523.16

8473 CENTIMETER WAVELENGTH RADIO ASTRONOMY INCLUDING OBSERVATIONS USING THE MASER.
J.A.Giordmaine.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 3, 267-76 (March, 1960).

Previous measurements made at centimetre wavelengths are summarized and the potentialities of new receiver devices such as travelling wave tubes, parametric amplifiers and masers are outlined. Observations were taken at 3 cm wavelength using a maser in conjunction with the 50 ft N.R.L. antenna. The temperature of Venus was found to be 575 ± 58° K. Jupiter at this wavelength has a temperature of 177 ± 22° K which can be interpreted entirely in terms of thermal emission from NH_3. Mars is at 211 ± 28° K. No emission was found from planetary nebulae greater that 0.1° K antenna temperature. R.D.Davies

523.16

8474 RADIO EMISSION FOLLOWING THE FLARE OF AUGUST 22, 1958. A.Boischot and J.W.Warwick.
J. Geophys. Res., Vol. 64, No. 6, 683-4 (June, 1960).

Records on 18, 40, 60, 169, 470 and 2800 Mc/s are shown for the activity associated with the importance 3 flare of 22 August, 1958. It is suggested that two types of emission are observed: (a) a burst observed at 470 and 2800 Mc/s, followed by (b) longlived continuum emission at the lower frequencies which begins later, the lower the frequency. R.D.Davies

523.16 : 550.3

8475 SOLAR RADIO EMISSION OF SPECTRAL TYPE IV AND ITS ASSOCIATION WITH GEOMAGNETIC STORMS.
D.J.McLean.
Austral. J. Phys., Vol. 12, No. 4, 404-17 (Dec., 1959).

A new type of solar radio event, the type IV storm, first described by Boischot (Abstr. 4849 of 1960) has been identified on Dapto (New South Wales) radio-spectrographic records. It has been shown to be distinguishable from type I storms by (1) its smooth spectrum; (2) its close association with type II bursts; and (3) its remarkably close association with geomagnetic storms. In common with some type I storms, all type IV storms are found to be associated with very large solar flares. It appears possible to explain the production of type IV emission and the occurrence of the related phenomena in terms of a single cloud of gas which moves through the sun's corona.

523.16

8476 THE ETA CARINAE NEBULA AND CENTAURUS A NEAR 1400 Mc/s. II. PHYSICAL DISCUSSION OF THE ETA CARINAE NEBULA. C.M.Wade.
Austral. J. Phys., Vol. 12, No. 4, 418-29 (Dec., 1959).

For Pt I, see Abstr. 4867 (1960). The observations of NGC 3372 described in Pt I are discussed. Comparison of the flux densities at 85.5 Mc/s (Abstr. 6312 of 1956) and at 1400 Mc/s leads to a value of 10 000 ± 1000° K for the electron temperature of the nebula. Unpublished optical measurements of the distribution of surface brightness across the object indicate that there is a dense core about 24 min of arc in diameter, surrounded by a much less dense region with a diameter of 120 min of arc. Adopting the optically determined distance of 1400 parsecs (Hoffleit 1952), r.m.s. densities of 71 ions cm^{-3} in the core and 11 ions cm^{-3} in the outer region are found. The total mass of the object is not more than 25 000 solar masses. It is shown that several O-stars probably are needed to maintain the ionization of the nebula.

523.16

8477 INTERNATIONAL COOPERATIVE EFFORTS DIRECTED TOWARD OPTICAL IDENTIFICATION OF RADIO SOURCES. R.Minkowski.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 1, 13-19 (Jan., 1960).

An account of the results of attempts at optical identifications of sources in the 3C and Sydney surveys of radio sources. For only about 10% of the objects can possible identifications be made. Ten of these are class I sources which appear to be associated with supernovae. It is also confirmed that some of the class I sources are double and multiple elliptical galaxies. The majority of these sources are as yet unidenified possibly because many are similar to Cygnus A and beyond the reach of the optical telescopes or at least so faint as to prevent identifications with the present positional accuracy. It is pointed out, however, that some of the sources may be truly invisible objects of an unknown kind. It also appears possible that in some cases the radio source may be associated with material ejected asymmetrically from a galaxy and hence the optical and radio protrons may not coincide making identification in such cases difficult or impossible. C.Hazard

523.16

8478 TWENTY-ONE-CM STUDIES OF SOME INTERSTELLAR CLOUDS. R.D.Davies.
Rev. mod. Phys., Vol. 30, No. 3, 931-3 (July, 1958).

The Cygnus-X radio source is shown to be a large cloud of ionized hydrogen. A combination of continuum and hydrogen-line measurements show that it lies at 6 kpc and has dimensions of about 200 parsecs and a density of 6 atoms cm^{-3}. Other neutral hydrogen clouds have been detected as low temperature regions lying in front of the bulk of the hydrogen in the galactic disk. Kinetic temperatures were found in the range 25 to 60° K and velocity dispersions were found in the range 5 to 6.5 km/sec. R.D.Davies

523.16

8479 21 CM INVESTIGATION OF THE STRUCTURE AND DYNAMICS OF THE MILKY WAY BETWEEN 100° AND 120° GALACTIC LONGITUDE. B.H.Grahl.
ForschBer. Landes Nordrhein–Westfalen, No. 423, 77 pp. (1960). In German.

Individual 21 cm line profiles are presented for 61 points between 100° and 120° galactic longitude within ± 2° galactic latitude. The reduction of these profiles for statistical analysis of the motion of H I clouds is described, and average values for the density of H I atoms are given. Plotting the observed velocities against galactic latitude indicates that the motions are not entirely due to the effects of differential rotation. H.J.A.Chivers

523.16

8480 COMBINED PHOTOGRAPHIC AND RADIO ECHO OBSERVATIONS OF METEORS.
J.Davis, J.S.Greenhow and J.E.Hall.
Proc. Roy. Soc. A, Vol. 253, 121-9 (Nov. 17, 1959).

An experiment designed for the simultaneous photographic and radio echo observations of meteors is described. The observations were made by means of a meniscus Schmidt camera and two pulsed radio transmitters operating at frequencies near 36 Mc/s. An analysis is given of the radio echo and photographic measurements of a bright Geminid meteor. The radio echo duration is found to be several orders of magnitude less than would be expected on simple diffusion theory. This behaviour is explained in terms of the attachment of electrons to neutral oxygen molecules to form negative ions, and a value for the attachment coefficient is determined.

523.16

8481 THE EFFECT OF ATTACHMENT ON RADIO ECHO OBSERVATIONS OF METEORS.
J.Davis, J.S.Greenhow and J.E.Hall.
Proc. Roy. Soc. A, Vol. 253, 130-9 (Nov. 17, 1959).

The effects of the electron attachment to neutral air molecules on the characteristics of radio echoes from meteor trials are studied. Previously it has been assumed that diffusion processes were primarily responsible for the reduction of volume electron density in a meteor trail, and also in limiting the echo duration. A value of the attachment coefficient $\beta_a = 5 \times 10^{-16} cm^3 sec^{-1}$ was determined from combined photographic and radio echo observations of a meteor (see preceding abstract). An effect of an attachment coefficient of this magnitude is to reduce the expected echo duration by a factor of 1000 or more for a bright fireball. The observed relation between visual meteor magnitude and echo duration is explained by this mechanism, as are the departures from the wavelength squared variation of echo duration predicted by diffusion theory. Attachment processes also account for the observation that the final heights of enduring meteor echoes all centre about 95 km, even though bright meteors may show a maximum in light intensity below 80 km.

523.16 : 551.5

8482 RADIO INTERFEROMETRY AT THREE KILOMETERS ALTITUDE ABOVE THE PACIFIC OCEAN. I. INSTALLATION AND IONOSPHERE. G.Reber.
J. geophys. Res., Vol. 64, No. 3, 287-93 (March, 1959).

The apparent advantages of a Lloyd's mirror interferometer are

enumerated. A detailed description is given of the installation which is a variable spacing interferometer whose spacing changes in a smooth and continuous manner from zero to six kilometers during about one half hour. The ionospheric effects which appear as fluctuations are discussed. The ionospheric horizon was observed to be peculiarly high in the east. This may be due to a bulge in the earth's atmosphere near the equator or to the proposed ring current circulating around the equator 5.5 earth radii distant.

523.16

8483 RADIO INTERFEROMETRY AT THREE KILOMETERS ALTITUDE ABOVE THE PACIFIC OCEAN II. CELESTIAL SOURCES. G.Reber.
J. geophys. Res., Vol. 64, No. 3, 293-303 (March, 1959).

Observations were secured at 20, 30, 50, and 100 Mc/s. Fluctuations are greatly reduced by averaging data. Cassiopeia is found to be an elliptical ring 2.3' by 1.5' inside a halo, a few minutes of arc in diameter. The halo increases in size and intensity relative to the pairing at lower frequencies. Cygnus contains a nucleus $<1'$ wide by 2' long in a halo about 4' diameter. Hydra contains a source about 5' wide. Observations of the sun confirm that the maximum obscuration is toward the east. Surges from Jupiter at 30 Mc/s are discussed.

523.2 : 551.5

8484 INTERPLANETARY SPACE AND THE EARTH'S OUTERMOST ATMOSPHERE. S.Chapman.
Proc. Roy. Soc. A, Vol. 253, 462-81 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). The static temperature distribution T(r) in the solar corona is discussed theoretically on the basis of alternative idealized assumptions as to its state — in particular, for thermal conductive equilibrium and for turbulent adiabatic equilibrium. Up to a distance of 20 solar radii, T(r) is inferred from the electron density data given by Blackwell and others. It is concluded that T(r) lies between the conductive and adiabatic distributions. The influence of the rotation of the gas is considered; it does not much affect the inferred T(r) up to 20 solar radii, but ignorance of the rotation at greater distances at present precludes an estimate of the coronal electron density at the earth's distance. The coronal temperature extrapolated to this distance is judged to be or order 100 000° K — a high value, though less than that formerly estimated on the basis of thermal conductive equilibrium. The influence of the hot coronal gas on the earth's outermost atmosphere is discussed, including the conductive heat flow therefrom into our atmosphere.

523.3

8485 THE COLOUR DISCRIMINATION THRESHOLD FOR VISUAL OBSERVATION OF THE MOON'S SURFACE AND THE MAXIMAL COLOUR DIFFERENCES OF LUNAR OBJECTS. L.N.Radlova and V.V.Shraronov.
Astron. Zh., Vol. 35, No. 5, 788-91 (1958). In Russian. English translation in: Soviet Astron.–AJ (New York), Vol. 2, No. 5, 735-8 (Sept.-Oct., 1958).

523.3

8486 THE OTHER SIDE OF THE MOON. P.Moore.
J. Brit. Astron. Assoc., Vol. 70, No. 1, 60-2 (Jan., 1960).

A commentary on the first pictures of the averted face of the Moon taken by cameras housed in the nose of the Soviet lunar probe, Lunik III, on 7 October, 1959. D.R.Barber

523.3

8487 INDIGENOUS ORGANIC MATTER ON THE MOON. C.Sagan.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No.4, 393-6 (April, 1960).

523.3

8488 BIOLOGICAL CONTAMINATION OF THE MOON. C.Sagan.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 4, 396-402 (April, 1960).

523.4

8489 A NOTE ON THE "EFFECTIVE GREYSPHERE TEMPERATURE" AND "EFFECTIVE BOLOMETRIC ALBEDO" OF PLANETARY BODIES. V.A.Firsoff.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 131-4 (March, 1960).

These quantities are defined in an attempt to take some empirical account of the thermal properties of certain planetary bodies. G.A.Chisnall

523.4

8490 ABSOLUTE PHOTOMETRY OF VENUS IN THE ULTRAVIOLET AND INFRARED. I.K.Koval'.
Astron. Zh., Vol. 35, No. 5, 792-6 (1958). In Russian. English translation in: Soviet Astron.–AJ (New York), Vol. 2, No. 5, 739-43 (Sept.-Oct., 1958).

From 23 to 26 August, 1956, about 60 photographs were obtained in the neighbourhood of the quadrature, using the 270 mm reflector of the Kharkov Astronomical Observatory. The methods are detailed and the results tabulated.

523.4

8491 THE MARKINGS OF VENUS. EXPERIMENT WITH AN ILLUMINATED GLOBE. P.Moore and P.J.Cattermole.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 130 (March, 1960).

Six untrained observers were asked to draw what they observed on looking at the sphere through a telescope. The results were not conclusive as most of the markings drawn could be explained in terms of faulty illumination. J.M.Hough

523.4

8492 SATURN IN 1958. M.B.B.Heath.
J. Brit. Astron. Assoc., Vol. 70, No. 1, 29-32 (Jan., 1960).

No very marked changes in colour, or distribution, of main surface features were observed during 1958. Boggis (Perth, Australia) made visual observations of equatorial zone, north equatorial belt, north polar regions, and rings A, B, and C through six different colour filters. His results are tabulated. D.R.Barber

523.4

8493 SOME NOTES ON THE ORIGIN OF THE COLOUR OF THE MARTIAN DESERTS. H.French.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 136-8 (March, 1960).

It is suggested that red colour is due to ferric oxide and that the orange red is due to part of the oxide being changed into yellow hydroxide. Conditions on Mars are very suitable for this transition. J.M.Hough

523.5

8494 APPROXIMATIONS FOR THE ELECTRON DENSITY IN METEOR TRAILS. A.A.Weiss.
Austral. J. Phys., Vol. 11, No. 4, 591-4 (Dec., 1958).

The exact solutions of the equations governing the evaporation and ionization for a spherical meteor in an isothermal atmosphere, as given by Herlofsen(Abstr. 2881 of 1949), are compared with the approximate solutions usually used, based on the assumptions of small deceleration and high velocity. A new set of approximations has been introduced which gives considerably better results near the point of maximum electron density. G.M.Brown

523.5 : 538.42

METEOR–PLANET COLLISIONS. See Abstr. 6996

523.5

8495 CALCULATION OF COSMIC-RAY AGES IN THE IRON METEORITES 'CARBO' AND 'TREYSA'. H.Voshage and H.Hinterberger; R.R.Marshall.
Nature (London), Vol. 185, 88-9, 89 (Jan. 9, 1960).

A comment on the paper of Marshall (Abstr. 3413 of 1960) in which it is explained that they prefer to calculate the age difference rather than the asbolute age because of the uncertainty of the correct values for the production cross-sections of the potassium isotopes. Some mistakes are pointed out and Marshall in his reply agrees there were some errors. J.M.Hough

523.7

8496 SOLAR FEATURES ASSOCIATED WITH ELLERMAN'S SOLAR HYDROGEN BOMB. R.R.McMath, O.C.Mohler and H.W.Dodson.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 2, 165-9 (Feb., 1960).

At the McMath–Hulbert Solar Observatory records of the brilliant streaks bordering the H_α line in the solar spectrum (the so-called "solar hydrogen bomb") have been obtained through the years, 1955-1959, simultaneously with the Lyot interference filter and the vacuum spectrograph (within ~ 0.75 A of the H_α line at 6562 A), and with the 50 ft solar tower spectroheliograph at settings very close to either the H_α or CaII lines. Main results are: (1), the "bombs" are definitely not the invariable precursors of solar flares; (2), the identification of Ellerman's "bombs" with Lyot's "petits

points" appears incontrovertible; (3), "bombs" occur most frequently on the outer edges of sunspot penumbrae, and very rarely in spot-free plages; (4), the mean life-time of the "bombs" is ~ 10 min, with a minimum of 4.4 min. Some "bombs" have been observed to persist for several hours. D.R.Barber

523.74

8497 SOLAR FLARES, CONCURRENT COSMIC RAY BURSTS AND SUBSEQUENT GEOMAGNETIC STORMS.
S.L.Malurkar.
Acta phys. Hungar., Vol. 8, No. 3, 285-300 (1958).

Five large cosmic-ray bursts associated with solar flares have occurred in recent years two of which were associated with geomagnetic storms. The bursts along with the flares occurred when the active sun regions were near the central meridian or near the western limb and had a long previous history of more than usual activity. Geomagnetic storms occurred when the activity was near the central meridian only. The study of solar flares and cosmic-ray bursts in relation to available geomagnetic and solar data shows that some ordered classification of flares can be made. It is suggested that the particles responsible for the solar flares are positively charged and of neither low nor very high atomic number, e.g. Sr, Ba. W.Bardsley

523.74

8498 THE STRUCTURE OF THE VELOCITY FIELD OF MOTIONS IN LATITUDE OF NON-RECURRING SUNSPOTS. M.A.Klyakotko.
Astron. Zh., Vol. 35, No. 5, 739-47 (1958). In Russian. English translation in: Soviet Astron.–AJ (New York), Vol. 2, No. 5, 689-97 (Sept.-Oct., 1958).

The existence is demonstrated of a structure in the velocity field. A table is given of the latitude distribution of the mean velocities of motion of non-recurring sunspots for 1877-87. The extrema of the velocity distribution curves are identified and their correlation for different years is calculated.

523.74

8499 SUNSPOTS AND THE "WILSON EFFECT". W.M.Baxter.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 138-42 (March, 1960).

Two centuries of systematic observation of near-limb sunspot groups fail to confirm that sunspots are invariably saucer-shaped depressions in the photospheric layer as is required for a positive Wilson effect. For whilst a majority of spot umbrae (~ 75%) have been found to give positive asymmetry of profile when seen near the solar limb, the remainder show either zero, or negative effects. D.R.Barber

523.74

8500 OBSERVATIONS ON PHOTOSPHERIC BRIGHTNESS SURROUNDING SUNSPOTS. R.A.Miller.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 146-7 (March, 1960).

An enlargement of a photograph taken at the Manila Observatory on 25.3.59 shows a bright ring around a large sunspot. The cause of the brightness was sought by studying the number of granules per unit area and their nature. The principle cause, especially in the penumbral width, was that the granules were closer together and catenated along lines which were extensions of the penumbral striations. J.M.Hough

523.74

8501 OBSERVATIONS OF SUNSPOTS DURING THE FIRST HALF OF 1957. F.Yilmaz.
Rev. Fac. Sci. Univ. Istanbul C, Vol. 23, No. 3-4, 201-9 (July-Oct., 1958). In French.

Regular observations of spots at the University Observatory, Istanbul, has continued. In the first six months of 1957 observations were possible on 143 days when a total of 332 groups was recorded. D.R.Barber

523.75

8502 DISTRIBUTION OF SIGHTLINE VELOCITIES IN SOLAR DISK AND LIMB PHENOMENA. J.H.Reid.
J. Brit. Astron. Assoc., Vol. 70, No. 3, 123-9 (March, 1960).

A summary of observations made during the International Geophysical Year of active prominences on the solar disk, and at the limb, as seen in H_α light with the spectroheliioscope of the Royal Observatory, Edinburgh. Drawings are reproduced depicting the detailed distribution of sightline velocities within the active regions, and their temporal variations for the active prominences of February 6, April 2, and August 14, 1958. D.R.Barber

523.75

8503 GREEN CORONAL LINE INTENSITY AND GEOMAGNETISM. C.Warwick.
J. geophys. Res., Vol. 64, No. 5, 527-31 (May, 1959).

Climax Observatory spectograms of the green coronal line, λ5303, for the period 1942-1944 near solar activity minimum have recently been remeasured. Analysis of these revised intensities shows that the most consistent feature in the relation of green line intensity to geomagnetism is a minimum in geomagnetic activity following central meridian passage (CMP) of regions of high green line intensity. This effect may be interpreted as a result of the tendency of solar activity regions to coincide with regions of high green line intensity and to avoid M regions. In the period October 1953 to October 1954, at sunspot minimum, no relation appeared between green line intensity and geomagnetic activity.

523.75

8504 KELLOGG AND NEY'S MODEL OF THE SOLAR CORONA.
D.E.Blackwell, D.W.Dewhirst, E.P.Ney and P.J.Kellogg.
Nature (London), Vol. 184, 1120-3 (Oct. 10, 1959).

In a critical discussion of Ney and Kellogg's coronal model (Abstr. 9156 of 1959), a number of discrepancies between the theoretical implications of the new "trapped corona" theory and accepted observational data are pointed out by Blackwell and Dewhirst, particularly with regard to polarization measurements of the coronal light. They conclude that Ney and Kellogg have not fully established their claim to have interpreted existing observations better than does the orthodox two-component model. In reply, Ney and Kellogg restate their claim that the presence of synchrotron radiation from a magnetically-contained corona is a likely possibility. They emphasize also that, in their view, the conventional F-corona is a spurious feature that needs to be removed before the true nature of the corona light can be properly determined. D.R.Barber

523.75

8505 ON AN ELEVEN-YEAR VARIATION OF THE MEAN HEIGHT OF THE CHROMOSPHERE. M.G.Fracastoro.
Ricerca sci., Vol. 29, No. 9, 1898-1911 (Sept., 1959). In Italian.

Measurements taken at Catania from 1922 to 1958 have been reanalysed, and establish an eleven-year cycle of variation of the annual mean chromosphere height, which is closely linked with the eleven-year solar activity cycle. J.Hawgood

523.77

8506 A CHANGE IN THE PROFILE OF SPECTRAL LINES DEPENDING DOUBTLESS ON THE VELOCITY GRADIENT OF MATTER IN THE ATMOSPHERE FROM WHICH THEY ORIGINATE. R.Servajean.
C.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2801-3 (April 20, 1960). In French.

Examination of high-resolution sunspot spectra, used to study the Evershed effect, has revealed significant modifications of the profile of a given absorption line that appear linked with the position within the spot from which the spectral radiation is received, and with the sight-line velocity gradient of the matter within the absorbing layer of atmosphere. D.R.Barber

523.77

8507 ULTRAVIOLET RADIATION AND THE EXCITATION OF OXYGEN LINES IN THE CHROMOSPHERE.
G.M.Nikol'skii.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 51-2 (Jan.1, 1960). In Russian.

The excitation of the oxygen lines λ 8446 and λ 7774 by radiation of wavelength 1025.73 A [second Lyman line] and by electron collisions is investigated. G.A.Chisnall

523.85

8508 THE PERSISTENCE OF SPIRAL STRUCTURE. K.H.Prendergast and G.R.Burbidge.
Astrophys. J., Vol. 131, No. 1, 243-6 (Jan., 1960).

It is shown that if it is assumed that material originally in a

spiral arm remains in that arm, and that velocities are circular and indpendent of time, the spiral arm will become completely distorted after one or two revolutions of the galaxy. R.A.Newing

523.85

8509 DISTRIBUTION AND MOTION OF INTERSTELLAR HYDROGEN IN THE GALACTIC SYSTEM WITH PARTICULAR REFERENCE TO THE REGION WITHIN 3 KILO-PARSECS OF THE CENTER. G.W.Rougoor and J.H.Oort.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 1, 1-13 (Jan., 1960).

After a brief discussion of the general features of the distribution of interstellar hydrogen in the galaxy, the distribution near the central regions is considered in some detail. At distances greater than about 4 kps from the centre the gas thickness between points at which the density is half the maximum density is about 220 parsecs and shows no large scale deviations from circular motion. Within 3 kps the thickness appears to be only about half the above value. At about 3kps there is a well defined arm partaking of the rotation of the galaxy but also showing large radial velocities. These velocities are assumed to be radially outwards and hence the arm called an "expanding arm". There also appears to be a disk of hydrogen extending to about 600 parsecs from the centre and rotating with high angular velocity. It is suggested that this disk consists of a well defined ring between 500 and 590 parsecs with a density of 1 atom per cm^3 and that inside this ring the density falls, until at a radius of about 300 parsecs it begins increasing to a very high value with approach to the centre. No expansion is observed in this disk. It is suggested that the gas observed to be streaming outwards from the centre may be replaced by an inflow of gas from the corona.
C.Hazard

523.85

8510 SYNCHROTRON RADIATION IN COMETARY NEBULAE. G.A.Gurzadyan.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 47-50 (Jan. 1, 1960). In Russian.

The continuous radiation of cometary nebulae is supposed due to synchrotron radiation from relativistic electrons. Formulae based on this assumption are quoted and applied to NGC 2261, whose characteristics are known from observation. The observational (including polarimetric) data appear to support the hypothesis.
G.A.Chisnall

523.85

8511 LARGE-SCALE STRUCTURE AND DIRECTION OF ROTATION IN GALAXIES. G. de Vaucouleurs.
Rev. mod. Phys., Vol. 30, No. 3, 926-30 (July, 1958).

Galaxies are classified by a 3-dimensional scheme whereby the 4 galactic classes introduced by Hubble are each subdivided according to whether they show in addition, ordinary, barred, ringed or spiral structure. Examples are given. The direction of rotation of a number of galaxies is determined from a study of the obscuration pattern produced by the spiral arms. The spiral arms are found to be trailing.
R.D.Davies

523.85

8512 A THIRD INTEGRAL OF MOTION IN A GALAXY. G.Contopoulos.
Z. Astrophys., Vol. 49, No. 4, 273-91 (1960).

A formal third integral of motion in a galaxy is found in the form of a series. One begins with the special case where the potential function is given by

$$2W = \frac{C^2}{r^2} - P\xi^2 - Qz^2 + 2b\xi z^2,$$

where $\xi = r - r_0$. Then the third integral has the form $\Phi = \Phi_0 + b\Phi_1 + b^2\Phi_2 + \ldots$ where Φ_i are polynomials in ξ, z and $R(= d\xi/dt)$, $Z(= dz/dt)$. Similar results are found in the general case when W is a series in ξ and z. The question of the convergence of Φ remains open. As an application of the new integral, a calculation is made of the boundary of the space filled by an orbit in the ξ,z plane; this space is approximately a trapezium. The results are in very good numerical agreement with the shape of two orbits calculated previously by means of an electronic computer.

523.87

8513 THREE-COLOUR PHOTOMETRY OF THE BLACK BODY. M.Golay.
Arch. Sci. (Geneva), Vol. 12, No. 3, 375-92 (July-Sept., 1959). In French.

Magnitudes, colour indexes, effective wavelengths and values of colour excess have been calculated for stars radiating as black bodies at different temperatures, assuming different thicknesses of interstellar matter. The effect of breadths of the spectral transmission bands of the filters used in the photometric system has been studied. It is possible to choose a system giving a linear relationship between the colour excess and the thickness of the interstellar matter.
J.W.T.Walsh

523.87

8514 THE VISIBILITY OF LINES OF LOW INTENSITY IN STELLAR SPECTRA. L.Houziaux.
C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2134-6 (March 21, 1960).

A discussion of the parameters (instrumental and photographic) that combine to set an upper limit to the intensity of just-detectable line features in stellar spectrograms.
D.R.Barber

523.87

8515 SPECTRA OF SOME METAL LINE STARS. E.Bohm-Vitense.
Z. Astrophys., Vol. 49, No. 4, 243-65 (1960). In German.

All known observational results about these stars are reviewed and som new data presented and discussed. It turns out that temperature of a metal line star is essentially the same as that of a normal main sequence star with the same hydrogen spectral type. In the high atmospheric layers, the electron pressure must be lower, while in the deeper atmospheric layers it is about equal to the electron pressure of a main sequence star with the same temperature. All proposals made so far in order to explain the spectra of the metal line stars are discussed. It is shown that none of them can reproduce the observational results. It is supposed that the peculiar features of the spectrum might be due to an atmosphere which is blown up considerably in its outer parts, possibly by magnetic fields.

523.877

8516 MODELS OF MASSIVE STARS IN HELIUM-BURNING STAGE. C.Hayashi, J.Jugaku and M.Nishida.
Astrophys. J., Vol. 131, No. 1, 241-3 (Jan., 1960).

Various physical characteristics are computed for a sequence of model stars designed to illustrate evolutionary processes in a star with a helium-burning core surrounded by an expanding hydrogen-burning shell.
R.A.Newing

523.877

8517 THE INTERNAL STRUCTURE OF SUPER-DENSE STARS. D.A.Kirzhnits.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 503-8 (Feb., 1960). In Russian.

The peculiarities of a "condensed state–plasma" phase transition in ultra-compressed matter are considered and it is concluded that the core of dense white dwarfs may be in a condensed state. As a result, the rate of nuclear processes is much lower (compared to that in a plasma) and the possible concentration of hydrogen in the matter of white dwarfs may be much higher.

525

8518 OSCILLATIONS OF THE EARTH. Z.Alterman, H.Jarosch and C.L Pekeris.
Proc. Roy. Soc. A, Vol. 252, 80-95 (July 7, 1959).

A study is made of the free and forced oscillations of the earth. The natural periods are determined for radial, torsional and spheroidal types of oscillation. Several models of the earth are used: a homogeneous model, such as was assumed originally by Love (1911), a model consisting of a homogeneous solid mantle enclosing a homogeneous liquid core, Bullen's model B (1950), and Bullard's models I and II (1957). It is found that the spheroidal oscillation of order 2 has a period of about 53.5 min in all models, except the homogeneous one, for which this period is only 44.3 min. The common period of 53.5 min agrees to within the observational error with the period of 57 min observed by Benioff (1954) on the seismograms of the Kamchatka earthquake of 1952. In contrast to all the other models, Bullen's model B possesses an additional spheroidal oscillation of order 2 of a period of 101 min. The latter oscillation is confined mainly to the core, its amplitude in the mantle being relatively very small. Benioff's observation of a second oscillation of a 100 min period in the Kamchatka earthquake record might be considered as evidence favouring Bullen's model B. The latter differs from Bullard's models mainly by having a central density of around 18 instead of about 12 g cm^{-3}. However, a theoretical investigation of the relative excitation of the various free modes by an impulsive compressional point-source situated at

a shallow focal depth, shows that the amplitude of the 100 min oscillation should be more than 1000 times weaker than that of the 53.5 min oscillation. It is thus not clear how a near-surface earthquake could have excited the core oscillation. The spectrum of the free modes of oscillation has also been determined for n = 3 and 4, including the fundamental and the first two overtones for each case. The computed free periods of spheroidal oscillation range from 53.5 min down to a period of 8 min for the fourth overtone in the case n = 2. We have also treated the bodily tides for Bullen's and Bullard's models. Love's numbers were determined in the case n = 2 for tidal periods of 6, 6 $\sqrt{2}$, 12 h and ∞. The dependence of the Love numbers on the period is small, a maximum range of variation of 13% occurring in the k-values between the periods of 6 hr and ∞.

525

8519 DETERMINATION OF THE EARTH'S GRAVITATIONAL FIELD. J.A.O'Keefe.
Science, Vol. 131, 607-8 (Feb. 26, 1960).

Brenner et al. have pointed out that spurious variations may be introduced into computation of satellite orbits by a combination of the use of osculating elements and a maldistribution of the observations. They suggest that this circumstance is the source of the eccentricity variations in the Vanguard I orbit which have been attributed to the third zonal harmonic. This criticism is based on a misunderstanding of the Vanguard orbit and tracking programmes. The source materials for the present study of the third zonal harmonic were not osculating elements, and the observations were in fact uniformly distributed around the Vanguard I orbit.

525 : 621.396.946

8520 A DISCUSSION ON SPACE RESEARCH.
Proc. Roy. Soc. A, Vol. 253, 450-541 (Dec. 29, 1959).

Held in London November 1958 under the leadership of Massey. Introductory remarks by him are followed by thirteen papers. Abstracts of these papers will appear in this or subsequent issues of Physics Abstracts.

525

8521 SYMPOSIUM ON THE EXPLORATION OF SPACE
J. geophys. Res., Vol. 64, No. 11, 1647-1800 (Nov., 1959).

Held in Washington, April 1959 under the joint auspices of the National Academy of Sciences, the National Aeronautics and Space adminstration and the American Physical Society. Introductory remarks by Jastrow are followed by 12 papers interspaced with accounts of 3 round-table discussions. Abstracts of the papers will appear in this or succeeding issues of Physics Abstracts.

525

8522 THE UNITED STATES PROGRAMME IN SPACE RESEARCH. H.E.Newell, Jr.
Proc. Roy. Soc. A, Vol. 253, 538-41 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr. 8520 of 1960). A survey including the following topics; atmospheres; ionospheres; high-energy particles; fields; astronomy; controlled experiments.

525

8523 CAPABILITIES FOR SPACE RESEARCH. H.E.Newell.
J. geophys. Res., Vol. 64, No. 11, 1695-1712 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (See Abstr. 8521 of 1960). A brief survey of the planning and activities in the area of space research.

525

8524 EXPERIMENTAL RESEARCH PROGRAM IN THE SPACE SCIENCES. J.W.Townsend, Jr.
J. geophys. Res., Vol. 64, No. 11, 1779-87 (Nov., 1959).

Exploration of Space Symposium, Washington,(1959). (See Abstr. 8521 of 1960). An account of the new areas in satellite and space probe research that are now under consideration by the U.S. National Aeronautics and Space Administration.

525

8525 THE DETERMINATION OF THE PHOTOGRAPHIC POSITION OF AN ARTIFICIAL EARTH SATELLITE, USING TWO REFERENCE STARS. A.N.Deich.
Astron. Zh., Vol. 35, No. 5, 810-18 (1958). In Russian. English translation in: Soviet Astron.–AJ (New York), Vol. 2, No. 5, 758-66 (Sept.-Oct., 1958).

525 : 621.396.969.35

8526 AMATEUR RADIO MEASUREMENT OF SOVIET SATELLITES I AND II. J.Heywood.
J. Brit. Astron. Assoc., Vol. 70, No. 2, 79-89 (Feb., 1960).

An account of field-strength and Doppler-shift measurements made by a number of amateur groups in Great Britain. A detailed account is given of the method used to measure Doppler shifts and of the method of reduction of the results. C.Hazard

525

8527 THE APPROACHING DESCENT OF SPUTNIK 3 (1958 δ2). B.R.May.
Nature (London), Vol. 185, 729-30 (March 12, 1960).

A short note on Sputnik 3 as a visual object from the British Isles. H.J.A.Chivers

525

8528 RADAR OBSERVATIONS OF THE SECOND RUSSIAN EARTH SATELLITE (SPUTNIK II 1957 β).
J.G.Davies, J.V.Evans, S.Evans, J.S.Greenhow, J.E.Hall, E.L.Neufeld and J.H.Thomson.
Proc. Roy. Soc. A, Vol. 250, 367-76 (March 24, 1959).

Observations were made using the 80 m steerable radio telescope at Jodrell Bank on frequencies of 36 and 100 Mc/s. An investigation of the fading characteristics of the echoes suggests that the observed fading arises from (i) Faraday rotation, (ii) ionospheric scintillation, (iii) rotation of the satellite. Evidence produced which suggests that (i) was not the principal cause of the fading under conditions of these experiments, and that (ii) the scintillation effects arise in a diffracting region at a height not greater than 220 km, which is contrary to the results obtained in the study of the scintillation of radio stars. The effect (iii) seems to have been responsible for most of the observed fading and it would appear that the satellite was rotating about an axis which was nearly perpendicular to its major axis. The effective scattering area of the satellite at 100 Mc/s was of the order of 15 m^2 but at 36 Mc/s it varied between 10 and 500 m^2. From this it is concluded that the satellite was a long object having a re-radiation polar diagram with one major and many minor lobes. No evidence was obtained to indicate that the satellite produced any ionization detectable at these frequencies, although it was observed as late as the third orbit before final burn up. Successful contacts were made on only about one-quarter of the transits observed. It has been possible to establish in retrospect whether the satellite passed through the main beam of the aerial. Such an analysis shows that on many occasions where no echoes were obtained the telescope was correctly positioned, and the failure to obtain echoes on these occasions is attributed to deep fading introduced by the rotation of the satellite and by Faraday rotation of the plane of the radio waves.

525

8529 MOTION OF A SATELLITE IN THE EARTH'S GRAVITATIONAL FIELD. G.V.Groves.
Proc. Roy. Soc. A, Vol. 254, 48-65 (Jan. 19, 1960).

The equations of motion of a satellite are given in a general form, account being taken of the precession and nutation of the earth. The main part of the paper deals with the motion arising from the gravitational field of the earth, expressed as a general expansion in spherical harmonics. By evaluating the partial derivatives in Lagrange's planetary equations, expressions are obtained for the rates of change of the orbital elements. Particular consideration is given to the form of the expressions for the secular terms arising from the first four zonal harmonics.

525

8530 EFFECTS OF SOLAR RADIATION PRESSURE ON EARTH SATELLITE ORBITS.
R.W.Parkinson, H.H.Jones and I.I.Shapiro.
Science, Vol. 131, 920-1 (March 25, 1960).

Calculations show that, at a mean altitude of 1000 miles, radiation pressure can displace the orbit of the 100 foot Echo balloon at rates up to 3.7 miles per day, the orbit of the 12 foot Beacon satellite at 0.7 mile per day. For certain resonant conditions, this effect accumulates, drastically affecting the satellite's lifetime.

525

8531 PERTURBATIONS IN PERIGEE HEIGHT OF VANGUARD I. P.Musen, R.Bryant and A.Bailie.
Science, Vol. 131, 935-6 (March 25, 1960).

The effect of solar radiation pressure on the perigee height of satellite 1958β2 (Vanguard I) has been considered. Previous consideration of the effect of the third harmonic and the lunar and solar

gravitational perturbations left an unexplained discrepancy between the observed and calculated values of perigee height. The inclusion of the effect of radiation pressure leads to close agreement between the orbit data and the theoretical results for Vanguard I.

525 : 551.5

SOME DEDUCTIONS OF IONOSPHERIC INFORMATION FROM THE OBSERVATIONS OF EMISSIONS FROM SATELLITE 1957α2. See Abstr. 8395-6

529

8532 AN ABSOLUTE SCALE OF TIME. J.A.Carroll.

Nature (London), Vol. 184, 260-1 (July 25, 1959).

Physical time, usually measured by counting the number of times a cyclic process is repeated can, in principle, be measured by choosing a purely random process and defining equal intervals of time as those during which random events are equally likely. Since radioactive decay is believed to be virtually independent of environment it is suggested as a basis of such time measurement. It is shown that using two radioactive clocks, a true or "absolute" scale of time can be derived. It is not suggested that a useful practical system of this sort could be constructed because the accuracy attainable in counting the number of disintegrations is far too low. It is also shown that the scale of time derived, in principle, from the two clocks is independent of their nature and could be of any desired precision if the clocks contain enough atoms. The accuracy of the scale might be a test of the assumption that radioactive decay is a random process. C.F.Barnaby

529

8533 STOCHASTIC RECTIFICATION OF NON-LINEAR CLOCKS. D.G.Kendall.

Nature (London), Vol. 184, 1476 (Nov. 7, 1959).

It is shown that the owner of a non-linear clock (such as described in the preceding abstract) can rectify it if he observes the motion of a Brownian particle (in the sense of Norbert Wiener).

C.F.Barnaby

PHYSICS

GENERAL

53

8534 THE PHYSICAL SOCIETY'S EXHIBITION — LONDON, 1960. T.B.Rymer.

J. sci. Instrum., Vol. 37, No. 5, 153-6 (May, 1960).

A general survey is given of the newer developments of instruments and apparatus exhibited, together with some observations on the Exhibition.

53

8535 MEASUREMENTS WITHOUT DISTURBING THE MEASURED OBJECT. M.Renninger.

Z. Phys., Vol. 158, No. 4, 417-21 (1960). In German.

The possibility of performing "negative" measurements, which consist in noting the lack of an event expected with a certain probability, is pointed out. It then follows that although such a negative measurement obviously does not interfere with the object, nevertheless it brings about a reduction of the wave-function. A short appendix contains critical remarks of Heisenberg on the interpretation of the measuring process in general. P.Roman

GRAVITATION . RELATIVITY

530.12 : 523

THE RELATIVISTIC INTERPRETATION OF ASTRONOMICAL OBSERVATIONS. See Abstr. 8468

530.12

8536 DISCONTINUITIES IN SPHERICALLY SYMMETRIC GRAVITATIONAL FIELDS AND SHELLS OF RADIATION. W.Israel.

Proc. Roy. Soc. A, Vol. 248, 404-14 (Nov. 25, 1958).

Boundary conditions at a 3-space of discontinuity Σ are considered from the point of view of Lichnerowicz. The validity of the O'Brien–Synge junction conditions is established for coordinates derivable from Lichnerowicz's "admissible coordinates" by a transformation which is uniformly differentiable across Σ. The coordinates r,θ,ϕ,t, used by Schwarzschild and most later authors when dealing with spherically symmetric fields, are shown to be of this type. In Schwarzschild's coordinates, the components of the metric tensor can always be made continuous across Σ, and simple relations are derived connecting the jumps in their first derivatives. A spherical shell of radiation expanding in empty space is examined in the light of the above ideas, and difficulties encountered by Raychaudhuri in a previous treatment of this problem are cleared up. A particular model is then discussed in some detail.

530.12

8537 FLAT SPACE-TIMES WITH GRAVITATIONAL FIELDS. L.Marder.

Proc. Roy. Soc. A, Vol. 252, 45-50 (July 7, 1959).

The geometry of an extended region of space-time is not fully determined by the vanishing of the Riemann curvature tensor. This suggests the possible existence of a non-trivial gravitational field where space-time is flat. Two examples of such fields are considered with reference to their sources.

530.12

8538 RADIATION DAMPING IN A GRAVITATIONAL FIELD. B.S.DeWitt and R.W.Brehme.

Ann. Phys. (New York), Vol. 9, No. 2, 220-59 (Feb., 1960).

The validity of the principle of equivalence is examined from the point of view of a charged mass point moving in an externally given gravitational field. The procedure is a covariant generalization of Dirac's work on the classical radiating electron. Just as Dirac's calculation was kept Lorentz invariant throughout, so the present calculation is maintained generally covariant throughout. With the aid of bi-tensors, which are nonlocal generalizations of ordinary local tensors, the manifest general covariance of each step is achieved in an elegant and useful way. The Green's functions for the scalar and vector wave equations in a curved manifold are obtained and applied to the derivation of the covariant Lienard–Wiechert potentials. The computation of energy–momentum balance across a world tube of infinitesimal radius surrounding the particle world-line then leads to the ponderomotive equations including radiation damping. Because of the nonlocal electromagnetic field which a charged particle carries with itself, its use as a device to distinguish locally between gravitational and inertial fields is not strictly allowable. One should be prepared to find an explicit occurrence of the Riemann tensor in the ponderomotive equations, leading to the result that acceleration by a "true" gravitational field can produce bremsstrahlung, thereby causing a reactive force in addition to the force of inertia. It is remarkable, however, that such an explicit occurrence does not happen. The particle tries its best to satisfy the equivalence principle in spite of its charge. It is only prevented from doing so (i.e., from following a geodetic path) because of the fact that, contrary to the case of flat space-time, the electromagnetic Green's function in a curved space-time does not generally vanish inside the light cone, but gives rise to a "tail" on any initially sharp pulse of radiation. The ponderomotive equations have exactly the same form as Dirac found for the flat-space-time case except for the addition of an integral over the entire past history of the particle, reprensenting the effect of the "tail".

530.12

8539 QUANTUM LIMITATIONS ON THE MEASUREMENT OF GRAVITATIONAL FIELDS. A.Peres and N.Rosen.

Phys. Rev., Vol. 118, No. 1, 335-6 (April 1, 1960).

By means of the analogy that exists between the gravitational field, in the weak, quasi-static case, and the electromagnetic field, uncertainty relations are obtained for the average values of some of

the Christoffel symbols measured in two domains, similar to those for the components of the quantized electromagnetic field. Furthermore, it is shown that there exists a limitation on the accuracy to which the average value of a single one of these Christoffel symbols can be measured. The existence of uncertainty relations provides an argument in support of the standpoint that the gravitational field must be quantized.

530.12

8540 THE CLOCK PARADOX IN SPECIAL RELATIVITY. H.Jeffreys.
Austral. J. Phys., Vol. 11, No. 4, 583-6 (Dec., 1958).

It is held that both Builder's and Dingle's analysis of the clock paradox introduce concealed hypotheses and that the methods of the special theory cannot produce a unique answer. Builder's result, it is argued, cannot be right while that of Dingle may be right but the method of obtaining it is fallacious. T.R.Carson

530.12

8541 THE CLOCK PARADOX IN RELATIVITY. E.F.Fahy.
Austral. J. Phys., Vol. 11, No. 4, 586-7 (Dec., 1958).

Dingle's analysis of the clock problem is examined and a number of observational astronomical tests of its validity are suggested. T.R.Carson

530.12

8542 THE LORENTZ TRANSFORMATIONS. G.Builder.
Austral. J. Phys., Vol. 12, No. 3, 300-3 (Sept., 1959).

Jeffreys' criticism of the author's analysis of the clock paradox is challenged on the basis that he has taken insufficient account of the essentially empirical character of the special theory of relativity. It is argued that the empirical background of the principle of relativity shows that the scales of measurement in different inertial coordinate systems could be specified, and that the accuracy of predictions demonstrates the validity of this specification. T.R.Carson

530.12 : 537.54

8543 THE CLOCK PARADOX FOR MOTION OF CHARGED PARTICLES IN A MAGNETIC FIELD. A.A.Sokolov.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 1, 75-7 (March 1, 1960). In Russian.

An electron moving in a betatron is considered. The electron accelerates from rest with uniform angular acceleration, then moves with constant velocity for a time, and finally decelerates uniformly to rest again. The total proper-time interval for the electron is computed and the significance of the resulting formula briefly discussed. O.Penrose

530.12

8544 THE DETERMINATION OF THE GRAVITATIONAL DEFLECTION OF LIGHT. E.Finlay-Freundlich.
Naturwissenschaften, Vol. 47, No. 6, 123-7 (1960). In German.

A detailed discussion of errors involved in determinations of the light deflection L. Small changes in the scale factor S of the telescope would give rise to a large uncertainty in L. The importance of the accurate and independent determination of S is emphasized. R.A.Newing

530.12 : 539.14

GRAVITATIONAL RED SHIFT MEASUREMENT USING THE MÖSSBAUER EFFECT IN Fe^{57}. See Abstr. 7468

530.12 : 539.14

RED SHIFT MEASUREMENT IN AN ACCELERATED SYSTEM USING THE MÖSSBAUER EFFECT IN Fe^{57}. See Abstr. 7469

530.12 : 539.14

UPPER LIMIT FOR THE ANISOTROPY OF INERTIA FROM THE MÖSSBAUER EFFECT. See Abstr. 7470

530.12

8545 NOTE ON SCHIFF'S PAPER ON RELATIVITY. H.Bondi and C.W.Kilmister.
Amer. J. Phys., Vol. 28, No. 5, 508 (May, 1960).

It is suggested that Schiff's arguments (Abstr. 4934 of 1960) imply that the fact that g_{11} is the inverse of g_{00} in Scharzschild space is a direct consequence of the principle of equivalence. Attention is drawn to the question of the range of applicability of this principle. R.A.Newing

530.12

8546 THE MECHANICS OF GENERAL RELATIVITY. W.B.Bonnor.
Proc. Roy. Soc. A, Vol. 251, 55-65 (May 12, 1959).

It is shown how to obtain, within the general theory of relativity, equations of motion for two oscillating masses at the ends of a spring of given law of force. The method of Einstein, Infeld and Hoffmann (1938) is used, and the force in the spring is represented by a stress singularity. The detailed calculations are taken to the Newtonian order.

530.12

8547 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. III. EXACT PLANE WAVES. H.Bondi, F.A.E.Pirani and I.Robinson.
Proc. Roy. Soc. A, Vol. 251, 517-33 (June 23, 1959).

For Pt II, see Abstr. 4703 (1958). Plane gravitational waves are here defined to be non-flat solutions of Einstein's empty space-time field equations which admit as much symmetry as do plane electromagnetic waves, namely, a 5-parameter group of motions. A general plane-wave metric is written down and the properties of plane wave space-times are studied in detail. In particular, their characterization as "plane" is justified further by the construction of "sandwich waves" bounded on both side by (null) hyperplanes in flat space-time. It is shown that the passing of a sandwich wave produces a relative acceleration in free test particles, and inferred from this that such waves transport energy.

530.12

8548 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. IV. THE GRAVITATIONAL FIELD OF A FAST-MOVING PARTICLE. F.A.E.Pirani.
Proc. Roy. Soc. A, Vol. 252, 96-101 (July 7, 1959).

For Pt III, see previous abstract. It is shown, in an invariant manner, that the gravitational field of a fast-moving mass bears an increasing resemblance to a gravitational plane-wave field, the greater the speed of the mass.

530.12

8549 ON EINSTEIN'S RELATIVISTIC THEORY OF THE NON-SYMMETRIC FIELD. M.Ikeda.
Progr. theor. Phys., Vol. 18, No. 2, 154-62 (Aug., 1957).

A new formulation of Einstein's relativistic theory of the non-symmetric field is proposed. The transformation character of the field quantities is different in transformation character from the corresponding quantities in his formalism. The transposition invariance becomes no longer a postulate but a consequence of the theory. The field equations derived from the variation principle coincide formally with those obtained by Einstein and Straus.

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

530.14

8550 PROFESSOR LANDÉ ON THE REDUCTION OF THE WAVE PACKET. P.K.Feyerabend.
Amer. J. Phys., Vol. 28, No. 5, 507-8 (May, 1960).

It is commented that by pushing the temporal changes into the representatives, Landé's procedure (Abstr. 11796 of 1959) makes the dynamical variables time dependent, whereas in the usual presentation which is criticised by him, the variables do not change in time. J.K.Skwirzynski

530.14

8551 ON THE EQUATION FOR A DISTINGUISHED COMPONENT OF THE STATE VECTOR. K.L.Nagy.
Acta phys. Hungar., Vol. 7, No. 1, 167-9 (1957).

In a generalization of the Krolikowski-Rzewuski results (Abstr. 1886 of 1957) the equation of motion is derived using the interaction representation and arbitrary space-like surfaces. R.A.Newing

530.14

8552 ON THE QUANTUM-MECHANICALLY POSSIBLE PHYSICAL STATES. G.Fáy, I.Fényes and R.Török.
Acta phys. Hungar., Vol. 11, No. 2, 109-15 (1960). In German.

A very deep-going but mathematically simple analysis of the

properties of quantum-mechanical operators representing physical observables is given. In particular, it is shown and illustrated by several examples that in order to avoid various inconsequences, a more exact interpretation of the hermiticity property than usually given is necessary. P.Roman

530.14

8553 RELATIONS BETWEEN PATH INTEGRALS AND THE VARIATIONAL PRINCIPLES OF HAMILTON.
J.Vlieger, P.Mazur and S.R.de Groot.
Physica, Vol. 25, No. 1, 55-6 (Jan., 1959).

It is shown that Groenewold's representation (Abstr. 4294 of 1959) of the propagator of Schrödinger wave-functions leads to the modified Hamilton principle. P.M.Davidson

530.14

8554 THE GEOMETRY OF QUANTUM STATES. J.Schwinger.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 2, 257-65 (Feb., 1960).

See Abstr. 3449 of 1960. It is shown that the algebra of measurement symbols can be derived from the geometry of an N-dimensional space of states, or of an N^2-dimensional space of operators. J.Hawgood

530.14

8555 THE COMMUTATION RELATIONS OBTAINED FROM SCHWINGER'S ACTION PRINCIPLE. T.W.B.Kibble.
Proc. Roy. Soc. A, Vol. 249, 441-4 (Jan. 13, 1959).

It is shown that, without introducing the concept of anticommuting c-numbers, it is possible to formulate the action principle in such a way that it yields uniquely the commutation relations corresponding to Bose and Fermi statistics. This is achieved by considering more general additions to the Lagrangian than those discussed by Kibble and Polkinghorne (Abstr. 56 of 1958).

530.14

8556 LOCAL CONSERVATION LAWS IN GENERALLY COVARIANT THEORIES. J.G.Fletcher.
Rev. mod. Phys., Vol. 32, No. 1, 65-87 (Jan., 1960).

The author examines the situation created by the presence of many proposed energy laws. The connection between these various conservation laws is illuminated and inquiry is made into their uses. The conclusion is reached that the uses of the values of conserved quantities in generally covariant theories are far more limited than in other theories. New mathematical uses of conservation laws are described - their use in finding the source terms of gravitational field, in showing a connection between gauges and constraints, and in the Schwinger formalism for quantum mechanics. J.K.Skwirzynski

530.14

8557 QUANTUM TRANSITIONS IN THE ADIABATIC APPROXIMATION. A.M.Dykhne.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 570-8 (Feb., 1960). In Russian.

Probabilities of quantum transitions in a discrete spectrum were found in the adiabatic approximation under simplest assumptions with respect to the time dependence of the Hamiltonian. Change of the adiabatic invariants in time was examined for the case of a classical linear oscillator.

530.14

8558 A GENERALIZATION OF SLATER'S MEAN EXCHANGE POTENTIAL IN HARTREE–FOCK EQUATIONS FOR MULTICENTRE PROBLEMS. M.Balarin.
Z. phys. Chem. (Leipzig), Vol. 213, No. 1-2, 44-51 (1960). In German.

An attempt is made to generalize, for the case of multicentre problems, Slater's simplification (Abstr. 4113 of 1951) in the method of taking into account the exchange interaction. P.Roman

STATISTICAL MECHANICS
TRANSFER PROCESSES

530.16 : 539.2

8559 EXACT SOLUTION OF THE ASSOCIATION PROBLEM BY A MATRIX-SPINOR METHOD WITH APPLICATIONS TO STATISTICAL MECHANICS. H.S.Green and R.Leipnik.
Rev. mod. Phys., Vol. 32, No. 1, 129-41 (Jan., 1960).

Describes a new method of formulating and solving a certain type of combinatorial problem connected with crystal lattices, the problems being the enumeration of possible ways of disposing "links" between neighbouring sites (and more complicated geometrical figures formed from links) upon the lattice without overlap. Solution of various versions of this problem would be of considerable interest in a great many physical situations, some of which are listed.

[The method is indeed new and looks promising, but the paper clearly requires revision. The problem treated in Section 5(b) can be solved in a few lines by elementary methods. The alleged solution given in Section 5(c) does not have the symmetry between horizontal and vertical "links" required by the symmetry of the problem]. H.N.V.Temperley

530.16

8560 ON THE MIGRATION OF MOLECULES IN A GAS MIXTURE. C.Christov.
Acta phys. Hungar., Vol. 7, No. 1, 67-85 (1957). In German.

The probability for a given spatial displacement and velocity change of a molecule in a gas mixture is determined and is represented by an integral equation, a convergent series expansion, and two differential equations. Applications, in particular to the limiting case of the Brownian motion, are given and discussed. P.Roman

530.16

8561 ON THE STATISTICAL THEORY OF KINETIC PHENOMENA. II. M.I.Klinger.
Fiz. tverdogo Tela, Vol. 1, No. 8, 1225-38 (Aug., 1959). In Russian.

For previous work see Abstr. 571 (1960). By solving the equations of motion for the density matrix of a system under the influence of a generalized force of the nature of a temperature gradient, general expressions for the kinetic coefficients are obtained; these general expressions are used to find approximate formulae for weak electron–phonon interactions. The formulae introduced are applied to the consideration of thermal conductivity in semiconductors. R.F.Peieris

530.16

8562 NOTE ON THE EQUATION OF STATE FOR HARD SPHERES. O.K.Rice.
J. chem. Phys., Vol. 32, No. 4, 1227-8 (April, 1960).

An analytical expression is obtained for a function describing the pressure exerted on an "exclusion" sphere. Its limits of applicability are discussed in terms of the limiting density of randomized spheres and machine calculations. P.Gray

530.16

8563 SOME THEOREMS ON THE PERTURBATION OF BROWNIAN MOTION. R.O.Davies.
Physica, Vol. 24, No. 12, 1055-60 (Dec., 1958).

It is shown that results of MacDonald (Abstr. 2167 of 1958) for the thermal noise of slightly non-linear systems can be obtained systematically by applying perturbation theory to the Einstein–Smoluchowski equation of Brownian motion. R.O.Davies

530.16 : 537.3

8564 ON THE PROBLEM OF BROWNIAN MOTION OF NON-LINEAR SYSTEMS. C.T.J.Alkemade.
Physica, Vol. 24, No. 12, 1029-34 (Dec., 1958).

A kinetic derivation is given of the spectral noise intensity to a first order approximation and for relatively high frequencies only, for a non-linear RC circuit consisting of an idealized diode valve in thermal equilibrium and a capacitor. The discrepancy with results obtained by other authors (MacDonald and Van Kampen, Abstr. 2167 and 3733 of 1958) on the basis of a very general hypothesis, in which the mechanism of the noise-generating element is not kinetically specified, is discussed.

530.16

8565 QUANTUM THEORY OF BROWNIAN MOTION. I.Prigogine and S.Ono.
Physica, Vol. 24, Supplement, S184 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The equation of motion for the Wigner phase-space distribution function of a quantum mechanical system of infinite extent is, in general, obtained from the von Neumann equation for the density matrix. The temporal variation of the density matrix, however, depends sensibly upon the initial condition. If one adopts the random phase assumption, the initial condition and consequently the solution are much more simplified since all the off-diagonal elements vanish under this assumption. But, if any kind of inhomogeneity does exist in the system, there must be non-vanishing off-diagonal elements. However, the general feature of the solution of the von Neumann equation is extremely complicated for an arbitrary initial condition. The motion of one foreign particle in a gaseous medium in thermal equilibrium has been treated as the simplest example of a system with inhomogeneity. The quantum effect, in addition to the diffraction effect in the usual sense, arises from the temporal evolution of the off-diagonal elements. The magnitude of this effect arising from the interference between collision and inhomogeneity in space depends on the ratio $\lambda_T(=\hbar/\sqrt{mkT})/\Lambda$, where Λ is a characteristic length of spatial inhomogeneity. For the value $\lambda_T/\Lambda \cong 1$, the collisions are no longer localized at one point of the space and the system does not obey the Boltzmann type equation, and the conservation of energy is no more valid at each point of space, if one expresses the results in terms of the Wigner distribution function. The ordinary Boltzmann equation remains valid for the sufficiently small value of λ_T/Λ.

530.16

8566 QUANTUM STATISTICS OF INTERACTING PARTICLES; THERMODYNAMIC QUANTITIES AND PAIR DISTRIBUTION FUNCTION. S.Fujita and R.Hirota.
Phys. Rev., Vol. 118, No. 1, 6-26 (April 1, 1960).

For previous work, see Abstr. 898 (1960). An alternative approach to the quantum statistics of interacting particles is proposed. It consists of calculating the equilibrium thermodynamical quantities of the many-body system via the pair distribution function with the assumption that the particles interact with each other only through pair central forces. The proposed approach has some advantage over the usual treatment via the partition function in that the pair distribution function is easier to deal with than the partition function in certain circumstances particularly when the collective motion description of the system is desirable. This is because only the pair distribution function can be expressed directly in terms of the collective interaction which is closely connected with collective elementary excitation, such as a plasmon in the electron gas and a phonon in the hard-sphere boson gas. The equation of state as well as the internal energy are obtained in the form of integrals of the pair distribution function. The close analogy between the pair distribution function and the two-body propagator, which appears in the quantum field theory, makes it possible to analyse the former by the use of Feynman diagrams identical with those usually introduced for the latter. The collective interaction, which is defined by the sum of the direct and the indirect interactions, is introduced as a particular partial sum of the perturbation series of the pair distribution function. This is used in rewriting the pair distribution function in terms of the collective interaction. It is shown that, while the simple chain approximation to the collective interaction in the electron gas is responsible for the transfer of a plasmon, the same approximation to the collective pseudo-interaction in the hard-sphere boson system has a relation similar to that of transfer of a phonon, both cases occurring at low temperatures. The explicit calculation of the pair distribution functions for these systems at the absolute zero temperature is carried out up to the first order in the collective interaction (simple chain approximation). These results are used to calculate the ground-state energies. For the electron gas the energy thus obtained confirms Gell-Mann–Bruckner's calculation of the correlation energy. For the hard-sphere bosons the calculated energy reproduces the result of Lee, Huang, and Yang. The extension of the calculation to the finite temperature case is also indicated. In particular the classical Debye–Huckel equation of state for the electron gas is briefly discussed.

530.16

8567 DIAGRAM EXPANSIONS IN QUANTUM STATISTICS. H.B.Levine.
Phys. of Fluids, Vol. 3, No. 2, 225-45 (March-April, 1960).

The Montroll–Ward–Lee–Yang approach to quantum statistics is generalized to multicomponent systems. It is also generalized so as to include external fields. The formalism is constructed in a volume-dependent manner, and includes internal coordinates, such as spin, from the beginning. It is rigorously proved that the quantum-mechanical volume-dependent cluster integral may be expressed in terms of connected diagrams only. The rules for drawing these diagrams are given. By simply generalizing the meaning of the word "determinant", all arguments are made to apply to both Fermi–Dirac and Bose–Einstein statistics simultaneously. A statistics factor, $\gamma = \pm 1$, for bosons (fermions) is introduced, in terms of which single formulae apply to both statistics. Rules are stated, by means of which the γ dependence of the contribution to the pressure for any diagram is given in terms an elementary topological property of the diagram.

530.16

8568 GROUND-STATE ENERGY OF A MANY-FERMION SYSTEM. W.Kohn and J.M.Luttinger.
Phys. Rev., Vol. 118, No. 1, 41-5 (April 1, 1960).

A critique of the Brueckner–Goldstone perturbation series for the ground-state energy of an interacting gas of fermions. This energy is calculated by first constructing the grand partition function at finite temperature, and then carefully taking the limit as $T \to 0$. In general this leads to a series which differs from that of Brueckner and Goldstone. An exception is the case where both the unperturbed single-particle energy as well as the interaction potential have spherical symmetry. Reasons for the breakdown of the Brueckner–Goldstone formalism are briefly discussed.

530.16

8569 GENERALIZED CLASSICAL DYNAMICS, AND THE "CLASSICAL ANALOGUE" OF A FERMI OSCILLATOR. J.L.Martin.
Proc. Roy. Soc. A, Vol. 251, 536-42 (June 23, 1959).

Various ways of generalizing classical canonical dynamics are considered. It is found that there exist systems of c-number Hamiltonian dynamics possessing neither canonically conjugate dynamical variables nor Langrangian formulation. The possibility of a non-c-number classical dynamics is then considered and realized. Elementary examples of both types of dynamics are examined, and emerge as classical analogues of a Fermi oscillator. This is remarkable in view of the commonly held belief that a Fermi oscillator does not have a classical analogue. Not all possible classical analogues possess a Langrangian formulation : those which do are of particular interest, since they provide the means of setting up a kind of Feyman principle. See also following abstract.

530.16

8570 THE FEYMAN PRINCIPLE FOR A FERMI SYSTEM. J.L.Martin.
Proc. Roy. Soc. A, Vol. 251, 543-9 (June 23, 1959).

A scheme for representing vectors and matrices as functions of a certain abstract symbol λ is set up : though λ has no numerical significance, it is found to behave as if it were an eigenvalue of a certain singular matrix Λ. The resulting "eigensymbol" theory is developed and applied to the quantum theory of Fermi systems. It is shown how a Feynman principle for such systems may be formulated in analogy with the familiar Feynman principle for a system with canonical p and q. The results are illustrated by the case of a simple Fermi oscillator.

530.16

8571 ON THE (RELATIVISTIC) STATISTICAL THERMODYNAMICS OF AN ASSEMBLY IN MASS-MOTION. R.K.Pathria.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 3, 168-77 (1957).

Statistical thermodynamics of an ideal relativistic gaseous assembly in mass-motion is studied by introducing the constraint of a fixed non-zero momentum. The transformation equations, connecting the observations in the laboratory system K and in the rest system K^0, are obtained for various thermodynamical quantities, and the invariance of the degree of degeneracy is brought out. The dynamical aspect of the results is discussed, showing thereby that the assembly behaves as if it possessed an inertial mass given by $(E + PV)/c^2$.

530.19

8572 METHOD OF TRIGONOMETRICAL SERIES IN CALCULATING THE MODIFICATION OF INTENSITY OF MONOCHROMATIC RADIATION DUE TO MULTIPLE COMPTON SCATTERING IN STELLAR ATMOSPHERE. K.K.Sen.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 1, 50-7 (1957).

The method of solutions by the use of trigonometrical series, has been further applied to work out the problem of modification of intensity up to the second order, in a stellar atmosphere of slowly moving electrons. The primary radiation at the photospheric level has been assumed to be monochromatic which is represented by a δ-function. This case is of fundamental importance. The emergent intensity at the outer surface has been calculated for a particular value of optical thickness. The method has been checked by independent calculation of the first order intensity and comparison with Chandrasekhar's calculations made differently (Abstr. 1148 of 1948). It is shown that the second order calculations considerably modify those of the first order.

530.19

8573 ON THE LIMITS OF APPLICABILITY OF THE THEORY OF TRANSITIONAL RADIATION.

G.M.Garibyan and I.Ya. Pomeranchuk.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1828-31 (Dec., 1959). In Russian.

It is pointed out that if the polarization properties of the medium lead to the appearance of transitional radiation then the taking into account of the multiple scattering of the radiating particles may cause violation of the customary mechanism of the radiation. Appropriate formulae for this case are worked out. Finally, the number of bremsstrahlung and transitional radiation quanta are compared. P.Roman

GENERAL MECHANICS

531.25

8574 THERMAL STRESS ANALYSIS AND GRUENEISEN'S RELATION. A.M.Freudenthal.
J. appl. Phys., Vol. 31, No. 2, 434 (Feb., 1960).

It is proposed that inconsistency inherent in the conventional formulation of the thermal stress problem with respect to incompressibility are removed by using Grueneisen's relation between elastic constants and the coefficient of linear thermal expansion which is thus not an independent constant. J.K.Skwirzynski

531.25

8575 VIRTUAL WORK, LINEAR PROGRAMMING AND PLASTIC LIMIT ANALYSIS.

A.Charnes, C.E.Lemke and O.C.Zienkiewicz.
Proc. Roy. Soc. A, Vol. 251, 110-16 (May 12, 1959).

The open problem (since 1951) of the possibility of representing the static and kinematic plastic collapse principles for frames as dual linear programming problems is hereby resolved affirmatively. In process, a new relation between compatibility equations and static equilibrium equations is developed. Corollary advantages of the results are indicated.

531.25

8576 ON STABILITY IN THE VISCO-ELASTIC REGION WHERE A LINEAR LAW IS FOLLOWED. I.

J.N.Distéfano.
R.C. Accad. Naz. Lincei, Vol. 27, No. 5, 205-11 (Nov., 1959). In Italian.

The stability or otherwise of a given system subjected to a stress varying with time may be determined by applying Euler's criteria to a similar system with an amended value for the modulus of elasticity and subjected to a constant stress. Formulae are given for the necessary amendment to this modulus. No comparison with experiment is given. N.Corcoran

531.25

8577 ON STABILITY IN THE VISCO-ELASTIC REGION WHERE A LINEAR LAW IS FOLLOWED. II.

J.N.Distéfano.
R.C. Accad. Naz. Lincei, Vol. 27, No. 6, 356-61 (Dec., 1959). In Italian.

For Pt I see previous abstract. A theoretical discussion of the deformation of a beam fixed at one or both ends, with moment of inertia varying along its length, and subjected to a stress varying with time. It is shown that Euler's criteria are valid, used in conjunction with the treatment given in Pt I. N.Corcoran

531.25

8578 ON THE FINITE DEFORMATION OF A TUBULAR SOLID OF CURVED AXIS. G.Ferrarese.
R.C. Accad. Naz. Lincei, Vol. 27, No. 6, 347-55 (Dec., 1959). In Italian.

It is shown theoretically that by using a 3-dimensional curvilinear system of axes, certain deformation problems may by solved by simple mathematical treatment. This treatment is analogous to that for a tube of straight axis referred to rectangular co-ordinates. N.Corcoran

531.3

8579 APPROXIMATE THEORY OF AN AXIALLY-SYMMETRICAL GYRO WITH VARIABLE MASS.

N.S.Kalitzin.
Nuovo Cimento Suppl., Vol. 15, No. 3, 282-9 (1960). In German.

The equations of motion for a gyro whose mass continuously changes (e.g. rotating stars, supernovae, rockets) are formulated both for non-relativistic and for relativistic velocities.

J.K.Skwirzynski

531.5

8580 PENETRATION OF ROTATING SHAPED CHARGES. S.Singh.
J. appl. Phys., Vol. 31, No. 3, 578-81 (March, 1960).

An attempt is made to correlate theoretically the depth of penetration and the angular velocity of the liner in a rotating shaped charge. Each element of the rotating liner imparts an angular velocity to the corresponding jet element, and this results in a continuous increase of the cross-sectional area of the jet element as it travels in space and a corresponding decrease in the depth of penetration. In order to check the theory, numerical evaluations have been carried out in case of standard M9A1 steel cones. The theoretical results seem to explain the scanty published experimental data of the rotating shaped charges.

531.5

8581 EXPLOSIVELY LOADED METALLIC CYLINDERS. I. F.E.Allison and R.W.Watson.
J. appl. Phys., Vol. 31, No. 5, 842-5 (May, 1960).

Recent experiments using thin-walled metal cylinders internally loaded with high explosives have been performed in an effort to show that the casing velocity vector bisects the angle formed by the expanding cylinder and the undisturbed portion. This relation, which was first derived by Taylor (1941) can be expressed by the equation $\delta = \theta/2$, where δ is the angle between the velocity vector and the normal to the undisturbed casing, and θ is the angle formed by the normals to the moving and undisturbed portions of the casing. Although this relation forms a part of most theories pertaining to the acceleration of thin liners by high explosives, direct experimental verification of the relation has been difficult. In an attempt to verify Taylor's relation, values of δ were determined by inspecting the fragmentation patterns produced on cylindrical witness targets surrounding the charges. The values of δ determined in this manner are within the range of recent measurements by Singh using similar charges. Values of θ were independently determined from Kerr Cell photographs of the expanding cylinders. The experimental observations are in good agreement with the relation $\delta = \theta/2$.

531.5

8582 EXPLOSIVELY LOADED METALLIC CYLINDERS. II. F.E.Allison and J.T.Schriempf.
J. appl. Phys., Vol. 31, No. 5, 846-51 (May, 1960).

High-speed oscillographic pin technique was used to determine the radial displacment as a function of time for thin-walled copper cylinders internally loaded with high explosive (60RDX/40TNT). The results were compared with theoretical calculations based on Taylor's model for expansion of an incompressible cylinder and on the additional assumptions that the detonation products behaved as an adiabatically expanding polytropic gas. Theoretical calculations and experimental measurements were made for cylinders having a 0.500 in. inside diameter and seven different wall thicknesses ranging from 0.030 in. to 0.12 in. Although the experimental results agree with the calculated velocities at the larger radii, the data do not follow the theory in detail. During the initial expansion, the measurements show that the cylinder does not behave as an incompressible fluid, but is accelerated in a step-wise fashion characteristic of motion produced by shock waves.

531.57 : 539.6

PITS IN METALS CAUSED BY COLLISION WITH LIQUID DROPS AND RIGID STEEL SPHERES. See Abstr. 8142

MECHANICAL MEASUREMENTS

531.7 : 621.317.39

8583 OSCILLATOR MEASURING EQUIPMENT FOR VIBRATING-WIRE GAUGES. W.H.Ward and J.E.Cheney.
J. sci. Instrum., Vol. 37, No. 3, 88-92 (March, 1960).

It has been found that for some purposes the usefulness of the gauges has been restricted by limitations in the traditional reference-wire method of measurement. The design, construction, calibration and use of a new instrument which measures the frequency of vibrating-wire gauges is presented. It utilizes a variable-frequency electronic oscillator, which is continuously checked against a tuning-fork and regularly checked by time signals. Two models of the present version of the instrument have given very satisfactory performance under difficult conditions on civil engineering projects. The new instrument is cheaper and simpler to make than the traditional type and covers a frequency range of 250 to 2500 c/s.

531.71

8584 EXTENSOMETER FOR SEMI-RIGID MATERIALS. C.D.Kinloch and N.E.Waters.
J. sci. Instrum., Vol. 37, No. 3, 93-5 (March, 1960).

A differential capacitance extensometer is described which is capable of measuring extensions between 1 and 50% on an unstrained gauge length of one inch. With this instrument, complete tensile stress–strain curves to the point of rupture of the test piece may be obtained on semi-rigid materials.

531.71

8585 ELECTRO-OPTICAL DISTANCE MEASURING. A.Bjerhammar.
K. Tekn. Hogsk. Handl., No. 151, 101 pp.(1960).

A report on the examination of the reliability of a quartz crystal of BT cut used as an electro-optical light modulator at frequency 4 Mc/s. A theoretical analysis is made and at proper adjustment the fundamental frequency is obtained without distortion of even harmonics. Odd harmonics give no errors in a suitable phase discriminator. A 70% modulation is obtainable. Zero point drift of the instrument is studied. At a distance of 10^8 cm the standard deviation of a single measurement is ±1.1 cm. The instrument, described in detail, is called a Terrameter. Practical operating ranges are 50 m to 5 km. Total power consumption is 5.5W. Theory of modulation is studied in detail. 120 oscillograms are reproduced. S.Tolansky

531.74 : 621.317.39

8586 POSITION TRANSDUCER USING A DIVIDED CIRCLE AND CODED SCALE. I.R.Young.
J. sci. Instrum., Vol. 37, No. 4, 125-7 (April, 1960).

A small transducer is described in which a coded scale is used to distinguish the lines on a divided circle. This unit is intended as a positional reference in a large data-collecting system. The circle and code are both detected photoelectrically, through using very different cells and lamps. In order to keep the instrument diameter small, the coded scale is made in drum form.

531.75

8587 AN ELECTROMICROBALANCE FOR WEIGHING FIBRES. F.R.Morgan.
J. sci. Instrum., Vol. 37, No. 2, 53-4 (Feb., 1960).

A microbalance is described that has a capacity of about 1.5 mg and weighs to about 1 μg.

531.75 : 621.317.39

8588 AUTOMATIC RECORDING ELECTROMAGNETIC BALANCE. K.A.Lincoln.
Rev. sci. Instrum., Vol. 31, No. 5, 537-9 (May, 1960).

A simple recording electromagnetic weighing balance has been constructed and operated as a moisture sorption balance and as a flash pyrolysis weight-loss balance. A weight hanging at one end of a lever arm is equilibrated by the counter torque resulting from an armature (same axis of rotation as the lever arm) carrying an electric current flowing perpendicular to a magnetic field. The current is supplied from a d.c.amplifier which is controlled by light falling on a phototube. These components are interconnected in a feedback loop so that the weight of the sample, the amount of light striking the phototube, and the magnitude of the counter torque current are all sustained in dynamic equilibrium. The instrument has been operated over the 0 to 100 mg range and found to be linear and quite stable with a precision of 0.04 mg.

531.75 : 539.19

TORSION BALANCE MEASUREMENTS WITH MOLECULAR BEAMS. See Abstr. 7824

531.77 : 621.317.39

8589 YARN-SPEED METER — A LOW-TORQUE INSTRUMENT FOR MEASURING THE LINEAR SPEED OF LOW INERTIA SYSTEMS. D.L.Munden and T.K.Morley.
J. sci. Instrum., Vol. 37, No. 5, 157-9 (May, 1960).

A small portable low-torque tachometer is described which has been designed to measure linear speeds of running yarns or threads. The instrument is a simple capacitor-switching circuit, power being provided by a small mercury-amalgam cell contained in the handle of the instrument. The instrument has been used to measure yard speeds of up to 1200 ft/min to an accuracy of ± 1% within the calibrated limits.

531.78

8590 RAND SOIL-PRESSURE CELL FOR LOW PRESSURES, HIGH ACCURACY AND LONG-TERM STABILITY. J.E.Jennings and J.B.Burland.
J. sci. Instrum., Vol. 37, No. 6, 193-5 (June, 1960).

The cell is of a "balanced pressure" type and a linear differential transformer is used as a null point indicator to maintain a diaphragm in its zero position. The deflections of the diaphragm during pressure measurement may be kept very small, well within the limits required for soil pressure cells. The cell is used for direct and tangential pressures on the face of a rigid wall containing consolidating silt. The accuracy of observing the pressures lies within ±0.04 in. head of oil.

531.78 : 621.317.39

8591 METHOD OF MEASURING THE ANGULAR DEFLEXION IN A DYNAMOMETER. M.Axson and J.M.Magarshack.
J. sci. Instrum., Vol. 37, No. 3, 81-4 (March, 1960).

In the method described, unidirectional square-wave current pulses are produced with a mark-to-space ratio proportional to the deflection of the spring system in a dynamometer. The pulses are fed to a moving-coil meter which has a sufficiently slow response to read the mean current. The reading is then proportional to the deflection. Two systems for producing the square-wave pulses are discussed. The first is robust and simple in construction and can be applied when the forces to be measure are large. The second system can be used for the measurement of small forces where it is undesirable to make any physical contact with the dynamometer.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

532.1

8592 INTERACTION BETWEEN TWO EQUAL-SIZED EQUAL-SETTLING SPHERES MOVING THROUGH A VISCOUS LIQUID. H.W.Matthews and F.B.Smith; G.F.Eveson.
Brit. J. appl. Phys., Vol. 11, No. 2, 87-8 (Feb., 1960).

Correspondence agreeing that two identical spheres, falling in close proximity through a viscous fluid, are sometimes observed to develop slow rotations in opposite directions. There is conflicting experimental evidence as to whether the trailing sphere tends to overtake the leading one. J.G.Oldroyd

532.1

8593 METHOD FOR MEASURING BULK MODULUS OF A LIQUID USING A HELMHOLTZ RESONATOR. F.E.Ehlers.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 538-46 (May, 1960).

An analysis is given for a method of measuring the bulk modulus of a liquid by means of a Helmholtz resonator driven by an oscillating diaphragm in the cavity wall. The influence of the pressure transducer on the resonant frequencies is considered. In addition to the bulk modulus, the viscosity can be estimated by measuring the "Q"

of the cavity. One resonator was built, tested, and calibrated. Some difficulty was encountered in measuring resonant frequencies of the fluid-filled cavity at atmospheric pressure because of the formation of vapour bubbles. The results obtained for five common liquids compared favourably with earlier measurements of bulk modulus found in the literature. This method is especially suitable for measuring the bulk modulus of corrosive liquids since the liquid may be completely sealed in the cavity under pressure and no measuring probes are moved through the liquid.

532.1

8594 ACCURATE DIRECT-READING HYDROSTATIC BALANCE. A.T.J.Hayward.

J. sci. Instrum., Vol. 37, No. 4, 113-16 (April, 1960).

An apparatus has been built to enable the specific gravity of the water in the sump of the N.E.L. Hydraulic Machinery building to be read directly, with an accuracy of 1 in 50 000. A watertight, hollow, stainless-steel sphere, 15 in. in diameter, loaded with shot so that it just sinks in water, hangs from a semi-automatic balance in a Perspex tank through which sump water is circulated. Tables, based on a previous calibration of the apparatus with distilled water, enable balance readings to be converted directly to specific gravity values for any given temperature from 13.0 to 21.0°C. A cheap form of the apparatus for use in hydraulics laboratories is suggested. The possibility is discussed of increasing the accuracy to better than 1 part per million for research on the density of liquids.

532.1

8595 CAPILLARY VISCOMETER FOR NON-NEWTONIAN LIQUIDS. A.W.Sisko.

J. Colloid Sci., Vol. 15, No. 2, 89-96 (April, 1960).

A capillary viscometer having a wide range of shear rates (0.02 to 40 000 sec^{-1}) has been developed, and factors contributing to the response of the instrument have been analysed. The analysis showed that time and sample can be conserved by the proper selection of pressure gauges and by the exclusion of air. The instrument has been used to study the flow behaviour of lubricating greases over a range of shear rates wide enough that both pipe and capillary viscometers are usually needed to cover it.

532.1

8596 RHEOLOGICAL PROPERTIES OF BARYTES SUSPENSIONS. A.W.Earnshaw and J.C.Sproson.

Nature (London), Vol. 186, 378-9 (April 30, 1960).

Aqueous suspensions of barytes, containing particles of all dimensions up to 100 μ or 250 μ, showed a Bingham viscosity variation in a Ferranti rotating-cylinder viscometer at shear rates in the range 68 to 950 sec^{-1}. Extrapolated yield value and "plastic viscosity" are each plotted against concentration of solids by volume, up to about 40%. Linear graphs are obtained, for each size distribution, except for a discontinuity of slope in the graph of plastic viscosity, occurring at a concentration which decreases with increasing fineness of the solid phase. J.G.Oldroyd

532.1

8597 THE VISCO-ELASTIC BEHAVIOUR OF LUBRICATING OILS UNDER CYCLIC SHEARING STRESS.

A.J.Barlow and J.Lamb.

Proc. Roy. Soc. A, Vol. 253, 52-69 (Nov. 17, 1959).

The shear mechanical impedance of three base-stock lubricating oils was measured as part of an investigation into the influence of relaxation behaviour on lubrication. The oils selected were of high, medium and low viscosity index. Measurements of the mechanical impedance were made for frequencies of the cyclic shearing stress in the range 6 to 78 Mc/s: it was found possible in effect to extend this frequency range by equivalent variation of the temperature and pressure of the oil under test. Thus, all the experimental data for a given oil are reduced to a single universal curve for each component of the complex shear modulus, G*. This information is then analysed in terms of a relaxation spectrum. The practical and fundamental aspects of these results are discussed. In addition, results are given for a range of polydimethylsiloxane (silicone) liquids.

532.1 : 536.2

VISCOSITY AND THERMAL CONDUCTIVITY OF LIQUID BORON TRIFLUORIDE. See Abstr. 6980

532.1

8598 CONTRIBUTION TO THE STUDY OF THE ANGULAR OSCILLATIONS OF A CYLINDER IN A VISCOUS FLUID. M.Lehembre.

Verhandl. K. Vlaamse Acad. Wetensch., No. 60, 37 pp. (1959). In Flemish.

A theory is given of the damping of the angular oscillations (period T) of a cylinder about its axis when the cylinder is mounted between two parallel walls and immersed in a viscous fluid (viscosity η, density ρ). When the spacing between the cylinder and walls is either small or large with respect to the parameter $(T\eta/\rho)^{1/2}$, formulae from which the fluid viscosity can be evaluated are given.

T.S.E.Thomas

532.1

8599 THE EFFECT OF VELOCITY GRADIENT OF THE INTRINSIC VISCOSITY OF SOLUTIONS OF HIGH-MOLECULAR-WEIGHT POLYMER FRACTIONS. O.V.Kallistov.

Zh. tekh. Fiz., Vol. 29, No. 1, 70-4 (Jan., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 1, 61-4 (Jan., 1959).

A method of measuring the intrinsic viscosities of polymers at different velocity gradients is described. An evaluation is made of the nature of the effect of the solvent on the relation between the intrinsic viscosity and the velocity gradient. An empirical formula is obtained which describes this relationship over a range in gradient from 50 to 3000 sec^{-1}.

532.1

8600 DISCUSSION OF THE VISCOSITY OF MIXTURES OF LIQUIDS. L.Rothhardt and W.Ulrich.

Z. phys. Chem. (Leipzig), Vol. 213, No. 5-6, 366-9 (1960). In German.

The exponent in the Andrade equation plotted as a function of the mole fraction exhibits a maximum in the case of mixtures with a liquid which contains associated molecules. Also, the temperature dependence of the exponent is much smaller for, say, toluene and acetone than pure water, or the water–methanol, and water–acetone mixtures, which show the aforementioned maximum.

R.Schnurmann

532.1 : 539.3

DYNAMIC MECHANICAL PROPERTIES OF POLYETHYLENE FROM 25° TO 150°C. See Abstr. 8110

532.2

8601 THE STABILITY OF A VISCOUS LIQUID IN A VERTICAL TUBE CONTAINING POROUS MATERIAL. R.A.Wooding.

Proc. Roy. Soc. A, Vol. 252, 120-34 (July 7, 1959).

If a long vertical tube filled with porous material contains a viscous solution, the density of which increases with height as a result of the presence of the dissolved substance, the equilibrium of the liquid is stable provided that the density gradient does not anywhere exceed the value $d\rho/dZ = 3.390\ \mu\kappa/gkb^2$. Here κ, the diffusivity of the solute through the saturated porous medium, is defined to be the quantity of solute diffusing across unit area within the porous medium per unit time under unit density gradient. The above expression for the density gradient at neutral stability has been compared experimentally with Taylor's value for the corresponding density gradient in a vertical capillary tube. For a porous medium consisting of randomly packed glass spheres of mean diameter about 0.2 mm and porosity $\epsilon = 0.365$, it has been found that the two results are consistent provided that the ratio $\kappa/D\epsilon = 0.6333$, where D is the molecular diffusivity of the solute when the porous medium is absent. As this dimensionless ratio is a property of the porous material alone, it can be determined directly by diffusion measurements. An alternative method of measuring $\kappa/D\epsilon$, based upon an electrical analogue, has led to a value of 0.641 for the same porous material, which is in good numerical agreement.

532.2

8602 VARIABLE CAPACITANCE LIQUID LEVEL SENSORS. L.B.Wilner.

Rev. sci. Instrum., Vol. 31, No. 5, 501-7 (May, 1960).

The properties of continuous variable capacitance liquid level gauges are analysed, and the interrelations of hydraulic and electrical properties are examined. The analysis covers both conductive and nonconductive liquids and considers the "flowback" effects found in dynamic level fluctuations (such as waves and slosh). Design rules are given.

532.5 : 541.12

CHEMICAL REACTIONS IN INTERNAL FLOW SYSTEMS. See Abstr. 8297

532.5 : 539.3

8603 ANALOGY BETWEEN THE SLOW MOTION OF A VISCOUS FLUID AND THE EXTENSION AND FLEXURE OF PLATES: A GEOMETRIC DEMONSTRATION BY MEANS OF MOIRÉ FRINGES. T.H.Richards.
Brit. J. appl. Phys., Vol. 11, No. 6, 244-54 (June, 1960).

Some of the geometrical properties of the stream function are discussed and of Airy stress-function surfaces. Through these properties a method is described wherein visualization of flow and stress conditions is obtained by analogy, the flexure problem of plates being the vehicle for solution.

532.5

8604 A KINETIC THEORY OF LIQUID DISPLACEMENT. A.J. de Witte.
Phys. of Fluids, Vol. 3, No. 2, 197-204 (March-April, 1960).

A theory is formulated for the displacement of a liquid from a porous system by another liquid, miscible with the first. In its most general form, the theory also may be applied to nonmiscible liquids. Differential equations are derived for the concentrations and fluxes of the two liquids as functions of time and distance in one-dimensional flow. The equations are hyperbolic, in contrast to the equations, encountered in earlier theories of miscible liquid displacement which are parabolic. The differential equations are solved for given boundary conditions. Some numerical examples illustrate the solution in the simplest case of miscible displacement.

532.5

8605 FLOW OF POLYETHYLENE INTO A CAPILLARY. E.B.Bagley and A.M.Birks.
J. appl. Phys , Vol. 31, No. 3, 556-61 (March, 1960).

The flow of polyethylene from a reservoir into a capillary has been studied visually using a new technique for observing the flow patterns. Various patterns observed with different polyethylenes are shown, both below and above the critical shearing stress at which the extrudate becomes distorted. The technique is readily adaptable to observe directly the elastic energy stored in the melt above the capillary entrance and the rate at which this energy can be dissipated on the cessation of the steady flow into the capillary.

532.5

8606 AN EXAMPLE OF MINIMUM ENERGY DISSIPATION IN VISCOUS FLOW. D.G.Christopherson and D.Dowson.
Proc. Roy. Soc. A, Vol. 251, 550-64 (June 23, 1959).

An approximate theory is developed to describe the behaviour of a heavy ball passing slowly down a vertical tube having a diameter only slightly exceeding the diameter of the ball, and filled with a viscous fluid. It is shown that according to this theory the equations of motion can be satisfied when the ball takes up any degree of eccentricity in the tube and that any given eccentricity requires a particular velocity of rotation about a horizontal axis. It is found that the eccentricity ratio corresponding to minimum dissipation of energy for given velocity of descent (i.e. to maximum rate of fall for a given weight of ball) is about 0.98, and that the velocity is then rather more than twice the velocity corresponding to zero eccentricity. Experiments are described in which it was shown that provided conditions were such that the ball descended very slowly, the minimum dissipation prediction was verified within the expected accuracy, but that for larger clearances and more rapid fall the predicted angular velocity and eccentricity were not achieved within the times for which observation was possible.

532.5

8607 PERIODIC MOVEMENT OF VISCOUS INCOMPRESSIBLE LIQUIDS. V.I.Yudovich.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1214-17 (Feb. 21, 1960). In Russian.

The solutions of a particular type of non-linear partial differential equations are investigated and an existence theorem of temporally periodic solutions is established. It is applied to the flow of viscous liquids under the action of periodic body forces; in this problem it is assumed that the vorticity of the field of force is not zero.

R.Eisenschitz

532.5

8608 STABILITY OF INVISCID PLANE COUETTE FLOW. K.M.Case.
Phys. of Fluids, Vol. 3, No. 2, 143-8 (March-April, 1960).

The initial-value problem corresponding to a perturbed inviscid plane Couette flow is solved. Difficulties encountered in applying classical hydrodynamic-stability methods are avoided by considering the initial value problem.

532.5

8609 FLOW AND STRESS NEAR AN INTERFACE BETWEEN STRATIFIED LIQUIDS. K.Lofquist.
Phys.of Fluids, Vol. 3, No. 2,158-75 (March-April, 1960).

Observations are made of a density current system in which salt water flows turbulently under a pool of fresh water. The density and rate of flow of the salt water are varied, resulting in varying degrees of agitation of the interface. Measurements include the interface slope, the velocity and density profiles, and the rate of mixing. Profiles of stress and effective viscosity are developed from the observations and the equation of motion. In the zone of stable stratification the effective viscosity has a minimum equal to or greater than the molecular viscosity depending upon whether the interface is laminar or agitated. Dimensionless relationships between the observed or computed quantities and the given fluid properties and flow characteristics are investigated. The principle independent variables are a Reynolds number and a Froude number. An interfacial stress coefficient is found to depend upon both. With fair accuracy, the velocity profile can be related to the interfacial stress in a manner analogous to that for turbulent flow near a rigid boundary.

532.5

8610 THREE-DIMENSIONAL DISTURBANCES IN FLOW BETWEEN PARALLEL PLANES. J.Watson.
Proc. Roy. Soc. A, Vol. 254, 562-9 (March 8, 1960).

The close connection between the stability of three-dimensional and two-dimensional disturbances in flow between parallel walls has been examined and this has led to the formation of a three-dimensional stability diagram where "stability surfaces" replace stability curves. The problem which has been investigated is whether the most highly amplifying disturbance at any given Reynolds number above the minimum critical Reynolds number is a two-dimensional or a three-dimensional disturbance. It has been shown that the most unstable disturbance is a two-dimensional one for a certain definite range of Reynolds number above the critical. For Reynolds numbers greater than this no definite general answer has been found; each basic undisturbed flow must be treated separately and a simple procedure has been given which, in principle, determines the type of disturbance which is most unstable. Difficulty arises in following this procedure because it requires knowledge of the two-dimensional stability curves in a certain region where this knowledge is very scanty at the moment. Although this difficulty arises, in Poiseuille flow the calculations available indicate very strongly that the most unstable disturbance at any given Reynolds number above the critical is two-dimensional. Further, it is believed that this result holds for all other basic flows. A second result is that if the wave number (α) in the flow direction is specified, as well as the Reynolds number, then for α in a certain range, the most unstable disturbance is three-dimensional.

532.5 : 536.2

LAMINAR HEAT TRANSFER BETWEEN PARALLEL PLATES WITH AN UNSYMMETRICALLY PRESCRIBED HEAT FLUX AT THE WALLS. See Abstr. 6972

532.5 : 536.2

HEAT TRANSFER IN LAMINAR FLOW BETWEEN PARALLEL PLATES. See Abstr. 6973

532.5

8611 EFFECT OF TEMPERATURE VARIATIONS ACROSS THE LUBRICANT FILMS IN THE THEORY OF HYDRODYNAMIC LUBRICATION. W. B. Hunter and O.C.Ziemkiewicz.
J. mech. Engng Sci., Vol. 2, No. 1, 52-8 (March, 1960).

The effects of temperature variations within the thickness of the oil film, and the ensuing viscosity variations which are thought to be reponsible for the lift in parallel surface bearings, are studied with reference to the classical case of an infinitely wide inclined pad. A numerical solution for a typical bearing is obtained for different thermal boundary conditions and a comparison with results of the classical analysis is made. Very considerable differences from the classical analysis are obtained. Some results of the heat balance in bearings are presented.

532.5 : 536.22

8612 NOTE ON THE VARIATION OF TEMPERATURE DUE TO SMALL STEADY DISTURBANCES IN A COMPRESSIBLE [TWO-DIMENSIONAL NON-ADIABATIC] FLOW. M.Ray.
Bull. Calcutta Math. Soc. Vol. 50, No. 3, 150-4 (Sept., 1958).

532.5 : 536.2

8613 APPROXIMATE METHOD FOR INTEGRATING THE EQUATIONS OF A LAMINAR BOUNDARY LAYER IN AN INCOMPRESSIBLE GAS IN THE PRESENCE OF HEAT TRANSFER. M.B.Skopets.
Zh. tekh. Fiz., Vol. 29, No. 4, 462-70 (April, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 411-19 (April, 1959).

The solution is based on the use of a system of equations that are the successive moments (including the zeroth moment) of the equation of the boundary layer. This solution is an extension of the solution of the hydrodynamical problem obtained by Loitsyanskii (1949).

532.5 : 536.2

8614 HEAT EXCHANGE IN LAMINAR FLOW THROUGH NON-CIRCULAR TUBES. A.G.Temkin.
Zh. tekh. Fiz., Vol. 29, No. 4, 433-49 (April, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 383-400 (April, 1959).

Criteria for the effect of shape of the tube cross-section on the heat exchange in laminar flow are theoretically considered. Relationships between the Nusselt number, Nu, and certain shape factors are derived. It is shown, using available experimental data, that the theoretical relationships give values of Nu, correct to within 2.4%, for tubes of various cross-sectional shapes. S.Weintroub

532.5 : 536.2

FLOW PROCESSES OF SIMULTANEOUS HEAT AND MASS EXCHANGE IN HETEROGENEOUS SYSTEMS. See Abstr. 6959

532.5

8615 [CONSTANT] ROTATION OF A [INFINITE] PLANE LAMINA [ABOUT AN AXIS PERPENDICULAR TO ITS PLANE] IN NON-NEWTONIAN FLUIDS. A.C.Srivastava.
Bull. Calcutta Math. Soc., Vol. 50, No. 2, 57-64 (June, 1958).

532.5

8616 APPENDIX: ROTATION OF AN INFINITE PLANE LAMINA IN NON-NEWTONIAN LIQUID: MOTION STARTED IMPULSIVELY FROM REST. S.D.Nigam.
Bull. Calcutta Math. Soc., Vol. 50, No. 2, 65-7 (June, 1958).

532.5

8617 THE THEORY OF BOUNDARY LAYERS. J.Winter.
Cahiers de Phys., Vol. 13, 353-62 (Sept., 1959). In French.

The author stresses the elusive character of the boundary layer concept from the point of view of the Navier–Stokes equation and reviews attempts at mathematical description of this layer; Pradtl's demonstration; method of Karman–Polhausen, yielding an estimate of the layer thickness; and the method of Blasius.

J.K.Skwirzynski

532.5

8618 THE STABILITY OF A DIELECTRIC LIQUID JET IN THE PRESENCE OF A LONGITUDINAL ELECTRIC FIELD. N.K.Nayyar and G.S.Murty.
Proc. Phys. Soc., Vol. 75, Pt 3, 369-73 (March, 1960).

The stability of a cylindrical jet of incompressible inviscid liquid in the presence of a longitudinal electric field is investigated. It is shown that the electric field increases the stability of the jet. For given values of electric field, the wavelength of the disturbance at which the instability sets in and the wavelength which has maximum rate of instability are calculated.

532.5

8619 THE PROBLEM OF THE BREAK-UP OF HIGH-SPEED JETS OF WATER.
L.F.Vereshchagin, A.A.Semerchan and S.S.Sekoyan.
Zh. tekh. Fiz., Vol. 29, No. 1, 45-50 (Jan., 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 38-42 (Jan., 1959).

A jet was forced out of a nozzle of 1 mm diameter. The length of the coherent part of the jet was measured by means of an electric contact. The pressure of water before entering the nozzle was varied up to 1000 atm, and the length of the continuous part of the jet was obtained as a function of this pressure. In this range, the length varies between 178 and 40 mm. At 6 and at 200 atm there are marked maxima of length. R.Eisenschitz

532.5 : 536.2

8620 A [SIMPLE] METHOD FOR SOLVING PROBLEMS OF NONISOTHERMAL TURBULENT CONVECTION IN A CHANNEL FORMED BY PARALLEL PLANES. L.É.Ber.
Zh. tekh. Fiz., Vol. 29, No. 1, 61-9 (Jan., 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 52-60 (Jan., 1959).

A "turbulent viscosity" and "turbulent thermal conductivity" are introduced into the equations of motion and heat transfer, these quantities being determined from empirical data. Solutions of Reynolds' equations for the average flow which satisfactorily describe the velocity profile in the channel for a variety of boundary conditions are given. The heat transmission and the temperature distribution in turbulent flow between two parallel planes are found for two types of boundary conditions.

532.5

8621 LIQUID FLOW IN TUBES. I. THE TRANSITION PROCESS UNDER HIGHLY DISTURBED ENTRANCE FLOW CONDITIONS. E.R.Lindgren.
Ark. Fys., Vol. 15, Paper 8, 97-119 (1959).

Previously reported observations on the transition process in stream birefringment tube flow have been repeated in part. New photographic records are presented in order to improve the illustrative material of previous reports (Abstr. 3166 of 1954; 93 of 1959) with respect to the characteristics of the transition process. Some peculiar features of the stream birefringent effects of White Hector bentonite suspensions in tube flow have been discovered and are briefly discussed. An explanatory discussion shows that the turbulent spots as observed in Blasius flow and the turbulent flashes are observed in tube flow do represent two stages of development of one and the same transition process. They should not be interpreted as representing corresponding manifestations of the transition process appearing in different forms in the two types of flow. Explanation is also given of the processes of splitting of turbulent flashes within the transition region and to the "continuous" elongation of turbulent flashes (streaks) for higher Reynolds numbers previously observed and reported. The significance of the fact that disturbances emanating from the tube inlet have a considerably longer time of decay than eddies generated by turbulent flash bodies is discussed and appears to have a bearing on the vortex strength of the turbulent flash bodies. A recent determination of the intermittency factor as defined for the transition process in tube flow is examined and some necessary adjustments are proposed. Finally, an examination of the characteristics features of the turbulent flashes confirms that the turbulent eddies are produced within wall-near layers from where they diffuse into central parts of the flow where dissipation takes place. There are some characteristic mass transfer and velocity distribution patterns which appear to play an important role in the maintenance processes of the turbulent flashes.

532.5

8622 LIQUID FLOW IN TUBES. II. THE TRANSITION PROCESS UNDER LESS DISTURBED INLET FLOW CONDITIONS. E.R.Lindgren.
Ark. Fys., Vol. 15, Paper 37, 503-19 (1959).

Previous findings (Part I, see preceding abstract) are confirmed, according to which transition is caused by primary inlet disturbances of finite strength which cause the initiation of turbulent spots before they fade away and according to which the spots during their downstream travel develop into turbulent slugs. It also is confirmed that the fully developed turbulent slug should be regarded as being composed of a turbulent spot (or spots) travelling along the boundaries and of a central core of eddies with decay maintained by a process of continuous diffusion of eddies from the spot into the core. The "splitting" of turbulent slugs as well as the elongation of turbulent streaks, which phenomena have been reported previously (author, 1957), are found to be due to the core eddies being brought forward of their generating spots. Some of these always decaying eddies may, before they fade away, initiate the formation of a new spot ahead of the original one. The same process may then repeat itself with the new spots with a probability determined by the flow conditions. The

turbulent streaks and possibility also the self-preserving turbulent flow in general appear to be inhomogeneously maintained by discrete turbulent spots.

532.5

8623 LIQUID FLOW IN TUBES. III. CHARACTERISTIC DATA OF THE TRANSITION PROCESS. E.R.Lindgren.
Ark. Fys., Vol. 16, Paper 8, 101-12 (1959).

Qualitative studies on the transition process in tube flow of liquids (Pts I and II, see preceding abstracts) have been extended to cover also quantitative relationships of this phenomenon for flow of White Hector bentonite sols of various concentrations. Experimental evidence is presented which indicates that the transition process depends on some physical — say structural — properties of the liquids which are not accounted for by the coefficient of viscosity and the density. The findings actually demonstrate that the Reynolds law of similarity does not entirely apply to the flows investigated. These findings are supported also by studies of a new transition quantity, the maximum relative spot velocity (maximum relative velocity of the rear of the turbulent slugs as defined previously [Abstr. 93 of 1959]),the determination of which is independent of the viscosity of the liquids.

532.5

8624 SECONDARY FLOW IN A ROTATING ELLIPTIC PIPE. D.D.Mallick.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 3, 178-90 (1957).

The secondary fluid motion in an infinite tube through which a fluid is flowing under constant pressure gradient while the tube rotates about a principal axis of the elliptic cross-section has been worked out. The character of the flow is the same as in a circular tube, though the details of calculations are more complicated in the case of the elliptic section. It is, however, possible to satisfy the boundary conditions accurately.

532.5

8625 AN HYPOTHESIS CONCERNING TURBULENT DIFFUSION. R.Bourret.
Canad. J. Phys., Vol. 38, No. 5, 665-76 (May, 1960).

It is shown that the Goldstein equation for turbulent diffusion (see Abstr. 9326 of 1952) implies diffusion currents dependent upon the history of the concentration gradient. An analysis of the stochastic model upon which the Goldstein equation is based reveals that the hereditary function, by which the history is weighted, is the ensemble autocorrelation function of velocity. Heuristic arguments and an appeal to the theory of irreversible thermodynamic processes lead to the postulation of an integrodifferential equation for turbulent diffusion involving the velocity autocorrelations of the diffusate particles.

532.5

8626 A THEORY OF DECAYING HOMOGENEOUS TURBULENCE. R.G.Deissler.
Phys. of Fluids, Vol. 3, No. 2, 176-87 (March-April, 1960).

By considering correlations between fluctuating quantities at four points in a turbulent fluid, an equation containing quadruple and quintuple correlations is obtained. The equation is made determinate by neglecting the higher-order (quintuple) correlations. The combining of this equation with the two-and three-point correlation equations, and assuming a particular set of initial conditions, result in a solution which appears to represent the turbulence for times between the initial and final periods. The results reproduce most of the trends observed experimentally.

532.5 : 536.24

HEAT TRANSFER AND FRICTION IN TURBULENT VORTEX FLOW. See Abstr. 6977

532.5

8627 THE STABILITY OF VISCOUS FLOW BETWEEN HORIZONTAL CONCENTRIC CYLINDERS.
D.B.Brewster, P.Grosberg and A.H.Nissan.
Proc. Roy. Soc. A, Vol. 251, 76-91 (May 12, 1959).

The critical conditions for the formation of Taylor vortices between horizontal concentric cylinders are considered in detail: (1) where the flow is unidirectional round the annular space and is caused entirely by the rotation of the inner cylinder; (2) where the flow is caused entirely by pumping round the annular space; (3) where a liquid is caused to reverse its flow at a free surface, the flow being entirely caused by the rotation of the inner cylinder. The last case is analysed by the method of small disturbances and the conditions under which Taylor vortices will form are found. Results for the first two cases are already available in the literature. From examination of the three criteria a dimensionless number is proposed to correlate the critical values of the various parameters at the onset of these Taylor vortices. The proposed number has the advantage that it is insensitive to the velocity distribution in the annulus. It is subsequently used to predict the critical conditions for the onset of Taylor vortices under conditions that have not been analysed, i.e. where flow is due to pumping and rotation of the inner cylinder. The criterion is found to predict successfully the results of various experiments carried out. In addition experimental verification of the theoretical work of Dean (1928) and of the additional analysis carried out in this paper is also given.

532.5

8628 DEFORMED BEDS OF UNDULATING STREAMS AND THEIR STRUCTURAL PARAMETERS. B.A.Shulyak.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 275-8 (March 11, 1960). In Russian.

Derivation and practical verification of semi-empirical relations between the height and the wavelength of reefs formed on the bottom of undulating streams and the liquid density, density of solid bed, wavelength of waves, etc. Both stationary and travelling waves are considered. J.K.Skwirzynski

532.5

8629 POTENTIAL FLOW WITH WAKE PAST A SPHERICAL OBSTACLE. N.L.Ghosh.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 4, 253-7 (1957).

532.5

8630 WAVES PRODUCED BY A PRESSURE SYSTEM MOVING WITH AN ACCELERATION OVER THE SURFACE OF DEEP WATER. R.N.Bhattacharyya.
Proc. Nat. Inst. Sci. India A, Vol. 22, No. 3, 155-69 (1956).

The accelerated motion of the pressure system generates three kinds of disturbances of the free surface: (1) a more or less regular wave pattern y_1 propagating backwards, the wave number $k_0 = g/v^2$ depending on the instantaneous velocity of the centre of the pressure system. This wave dies out at a certain distance behind the moving pressure system. This represents an important deviation produced by acceleration from Havelock's result for constant velocity which gives a sinusoidal vibration behind the moving system with no decaying factor in time. (2) A small deviation effect y_2 extending to a small distance on either side of the moving system but very weak behind the starting point. (3) A direct acceleration effect propagating forwards depending on the wave number

$$k_1 = p/2X = g^{1/2}t/(2\tilde{\omega} + ft^2)$$

which attains a maximum value $g^{1/2}/2^{3/2}(\tilde{\omega}f)^{1/2}$. This represents the dominant effect when and where it exists. This component disappears along with the acceleration.

532.5

8631 WAVE RESISTANCE IN DEEP WATER DUE TO THE ACCELERATED MOTION OF A PRESSURE SYSTEM.
R.N.Bhattacharya.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 3, 191-8 (1957).

The wave resistance corresponding to the waves discussed in the preceding abstract has been worked out. It consists of three parts, R_1, R_2 and R_3. R_3 represents the direct effect of acceleration; R_1 and R_2 are analogous to Havelock's results (1917) for uniform motion of a pressure system. R_2 in any case is small, while R_3, due to acceleration, is more prominent than the other two components.

532.5

8632 ON THE APPLICATION OF RELAXATION METHODS TO OCEANIC TIDES. J.R.Rossiter.
Proc. Roy. Soc. A, Vol. 248, 482-98 (Dec. 9, 1958).

A numerical solution is obtained for the distribution of a tidal constituent in a narrow, meridional canal, bounded symmetrically near the poles, using the relaxation method of solving the partial differential equations governing tidal motion. Boundary conditions of zero normal current are satisfied, and only a knowledge of the tide-generating potential is assumed. The results are compared with those obtained from a series solution, and the accuracy of the method demonstrated. The method is extended to the two-dimensional problem of an ocean of uniform depth, on a rotating earth, bounded

by meridians and parallels, for the tidal constituent K_2. The boundaries and depth are chosen so as to conform roughly with those of the Atlantic Ocean. A feature of the method is the replacement of the co-latitude θ, as an independent variable, by ϕ, where $\phi = \ln \tan \frac{1}{2}\theta$. This substitution is necessary to avoid the excessive over-relaxation which would otherwise be required.

532.5

8633 OPTICAL STUDIES OF THE DIFFRACTION OF WATER WAVES BY CIRCULAR AND THIN ELLIPTIC CYLINDERS. R.Barakat and R.Barakat.
J. appl. Phys., Vol. 31, No. 3, 474-8 (March, 1960).

By using the optical grid method the diffraction of water waves from circular and elliptic cylinders was measured and compared with theory. The scattered wave intensity S and the total energy scattered per sec per unit intensity Q were measured and the results bear out the well-known fact that for angles less than 30 deg or in the vicinity of 180 deg, one cannot separate out the scattered wave and the incident plane wave. The optical grid method is described in detail and the advantage of its being able to measure the instantaneous field emphasized.

532.5

8634 DETERMINATION OF THE PROFILES OF WATER WAVES. J.A.Sandover and C.Taylor.
J. sci. Instrum., Vol. 37, No. 4, 141-3 (April, 1960).

A capacitor type depth gauge is described which facilitates accurate recordings of the profiles of three dimensional water waves propagated in prismoidal open channels. The circuitry, principle and calibration of the gauge are outlined, with particular reference to the advantages of using standard industrial equipment.

532.5

8635 A CLASS OF THREE-DIMENSIONAL SHALLOW-WATER WAVES. J.E.Chappelear.
J. geophys. Res., Vol. 64, No. 11, 1883-90 (Nov., 1959).

The problem of the calculation of the properties of three-dimensional waves (whose surface profiles have a two-dimensional structure) is discussed using the approximations of the shallow-water theory. Assuming the first approximation is a uniform flow, there is in the theory a critical speed nearly equal to the square root of the product of the acceleration of gravity and the depth. No steady waves can propagate slower than this velocity. Waves which have this critical velocity are essentially two-dimensional, since they differ from two-dimensional waves only by a steady current. The waves whose velocities are greater than critical may have a wide variety of behaviours, since in this case the velocity potential satisfies a differential equation of the hyperbolic type (in two-space co-ordinates, not the time) to the second order of approximation. Although no solution to the first approximation has been constructed other than the uniform flow, a proof that the uniform flow is a unique solution has not been found.

532.5

8636 THE DYNAMICS OF THIN SHEETS OF FLUID. I. WATER BELLS. G.Taylor.
Proc. Roy. Soc. A, Vol. 253, 289-95 (Dec. 15, 1959).

A simple solution of the equations representing the shape of an axially symmetric sheet of fluid is given. The shapes so calculated are compared with photographs of a "water bell" produced by placing a plane or conical obstruction in the centre of a jet of water. The effect of air friction is evident in one of the photographs, and calculation, using a formula due to Howarth, shows that it should have been expected, though previous discussions of water bells have assumed it negligible.

532.5

8637 DYNAMICS OF THIN SHEETS OF FLUID. II. WAVES ON FLUID SHEETS. G.Taylor.
Proc. Roy. Soc. A, Vol. 253, 296-312 (Dec. 15, 1959).

It is shown that capillary waves are of two kinds, symmetrical waves in which the displacements of opposite surfaces are in opposite directions, and antisymmetrical waves in which the displacements are in the same direction. Any disturbance can be regarded as composed of these two types of wave. The antisymmetrical waves are non-dispersive. In a sheet of uniform thickness a moving point disturbance produces two narrow line-like waves. In a radially expanding sheet a fixed disturbance point produces two narrow disturbances in the form of cardioids. It is shown theoretically that a finite change in direction of flow can occur at a cardioid which therefore assumes the form of a sharp edge. A method was found for producing and photographing a sheet with a sharp edge in the form of a cardioid. The symmetric waves are very different, they are highly dispersive and are propagated much more slowly than the antisymmetrical waves. Experimentally a point disturbance produces both kinds of wave simultaneously. Reflection photographs show the antisymmetrical waves, while the schlieren method is needed to reveal the symmetrical waves. The symmetrical waves produced in a moving sheet by a point disturbance are parabolas when the sheet is uniform in thickness, and of a more complicated form when the sheet is expanding. The predicted wave patterns agree with those revealed by the schlieren photographs.

532.5

8638 THE DYNAMICS OF THIN SHEETS OF FLUID. III. DISINTEGRATION OF FLUID SHEETS. G.Taylor.
Proc. Roy. Soc. A, Vol. 253, 313-21 (Dec. 15, 1959).

The free edge of a sheet of uniform thickness moves into it at the same speed, $(2T/\rho t)^{1/2}$, as antisymmetrical waves, sweeping the fluid into roughly cylindrical borders. Here T, ρ and t are surface tension, density and thickness of the sheet. In a radially expanding sheet t decreases with increasing radius and beyond a radius R where $(2T/\rho t)^{1/2}$ is greater than u the radial velocity of the sheet, the edge moves inwards faster than it is convected outwards. Photographs show that the edge of an expanding sheet establishes itself near but inside the radius R. The sheet produced by a swirl atomizer expands as a cone but photographs show that its thickness fluctuates very greatly at the point where it emerges from the orifice. The edge of a conical sheet of varying thickness establishes itself at a point well inside the radius at which $(2T/\rho \bar{t})^{1/2} = u$, $\bar{t}$ being the mean thickness. A moving sheet of uniform thickness can be bounded by a stationary free edge at angle $\sin^{-1}(W^{1/2})$ to the direction of motion. Here W, the Weber number, is $2T/\rho t u^2$. Photographs show free edges at this angle and therefore parallel to antisymmetrical waves. If this remained true in an expanding sheet the edges would coincide with the cardioids discussed in Pt II, but reasons are given to show that this is not the case. A small obstacle can divide an expanding sheet forming two edges which lie at the same angle to one another as the two cardioids, namely, $2\sin^{-1}(W^{1/2})$ but photographs show that these edges do not subsequently lie on cardioids.

532.5

8639 ENTROPY PRODUCTION AND PRESSURE WAVES. G.Rosen.
Phys. of Fluids, Vol. 3, No. 2, 188-90 (March-April, 1960).

Neglecting thermal conduction and viscous dissipation, the velocity-free equations of one-dimensional flow are derived with the inclusion of general fluid thermodymanics. The strength of finite amplitude pressure waves is introduced into the theory. This quantity is conserved if the entropy of each fluid particle remains constant with time. The growth or decay of the strength is examined for a perfect gas which produces entropy.

532.5 : 534.23

NONLINEAR OSCILLATIONS OF AIR BUBBLES IN WATER.
See Abstr. 6865

532.6

8640 A NEW METHOD FOR OBSERVING THE ROTATIONAL KINETIC EFFECT OF SURFACE TENSION. M.Borneas and I.Băbuţia.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2330-1 (March 28, 1960). In French.

The rotational kinetic effect exists in the mass of the liquid. Whilst the earlier observations (Abstr. 72 of 1960) had been made with the ring method of Lecomte du Noüy, the present measurements on water and benzene were made by a bubble pressure method, where the number of air bubbles was counted when the liquid was at rest and when it was rotated at 177 r.p.m. No rotational kinetic effect was observed at temperatures above 40° C.

Liquid	Temperature °C.	Number of bubbles: Liquid at rest	Liquid rotating
Water	6-8.5	221	196
	19	241	220
	98-59	363	364
Benzene	9.7-14	412	363
	20.5	423	371
	73-41	623	626

R.Schnurmann

532.6 : 536.48

8641 VAN DER WAALS FORCES IN LIQUID FILMS. I.E.Dzyaloshinskii, E.M.Lifshitz and L.P.Pitaevskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 1 (7), 229-41 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 161-70 (Jan., 1960).

A previously developed theory (Abstr. 5277 of 1956) of the molecular forces of interaction between solid bodies, the surfaces of which are brought to very small distances of one another, is extended to the case where the space between the bodies is filled with a liquid medium. It is shown, in particular, that two indentical bodies always attract one another whatever the "layer" between them. General formula are obtained for the thermodynamic quantities (chemical potential) of the liquid film from a knowledge of the spectral properties (the dielectric constant $\epsilon(\omega)$) of the liquid and the solid substratum. Limiting laws are found for the dependence of the chemical potential on the film thickness. The problem of the stability of films is considered and different possible cases of instability in well determined ranges of film thickness are noted. The possibility of the existence of very small, but non-zero, contact angles is noted. Liquid helium films are discussed.

532.6

8642 THE PROBLEM OF THE STABILITY OF A VISCOUS [LIQUID] FILM [FLOWING] ON A SOLID BODY WITHIN A STREAM OF GAS. A.A.Zaitsev.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1228-31 (Feb. 21, 1960). In Russian.

A layer of viscous liquid is flowing along the horizontal surface of a solid body. It is assumed that the distribution of velocity with height is proportional to the distance from the solid surface. The liquid is in contact with a gas in streamline flow, its direction of flow being the same as that of the liquid. The stability of the surface is investigated by the method of superposed perturbations. Results are shown in diagrams from which the effect of velocity, viscosity and surface tension can be derived. R.Eisenschitz

532.6

8643 CIRCULATION IN LIQUID DROPS. F.H.Garner and P.J.Haycock.
Proc. Roy. Soc. A, Vol. 252, 457-75 (Oct. 27, 1959).

A number of aspects of the motion of drops through liquids are discussed with a view to clarifying the physical picture of the mechanism by which the liquid/liquid interface influences the transfer of momentum and mass across it. Internal motion and distortion are shown to affect drag characteristics at relatively high Reynolds numbers (100 to 1000). The Hadamard and Hill vortex models are compared. The internal velocity distribution in a spherical drop is shown to agree with both models but external motion in the Stokesian region is only predicted by the former. At higher Reynolds numbers where a potential flow regime prevails, the external motion is more closely described by Hill's model. Vortices do not form in a drop until the Reynolds number reaches a critical value depending on the state of the interface and the viscosity of the drop liquid. Bond and Newton (1928) predicted that interfacial tension was the only variable affecting the transition but additional effects due to impurities and to the polarities of the component liquid molecules are also important, not only regarding the onset of vortex formation but also in relation to the extensiveness of circulation when underway. The presence of impurities such as very small concentrations of surface-active agents, although lowering the interfacial tension, greatly reduces the velocity of circulation in the vortex.

532.6

8644 EFFECT OF VISCOSITY ON THE SPLASH CAUSED BY A DROP OF WATER FALLING INTO A MIXTURE OF GLYCEROL AND WATER. A.G.D.Philip.
J. appl. Phys., Vol. 31, No. 4, 727-30 (April, 1960).

The effect of viscosity and velocity on splashes produced by low velocity water drops was investigated by means of high speed photography. Graphs have been constructed showing the effects on the time of duration of the various stages of the splash and a dimensional analysis in terms of the Reynold's number and Froude's number has been made.

532.6

8645 THE MECHANISM OF PARTIAL COALESCENCE OF LIQUID DROPS AT LIQUID–LIQUID INTERFACES. G.E.Charles and S.G.Mason.
J. Colloid Sci., Vol. 15, No. 2, 105-22 (April, 1960).

The mechanism of formation of a secondary drop from the coalescence of a liquid drop (Phase 1) at a liquid–liquid interface was investigated. It was shown by means of high-speed photographs that partial coalescence results from the formation of a liquid column of Phase 1 in Phase 2 which contracts at the base and detaches itself to form the secondary drop. The diameter ratio, secondary to primary, varied with the viscosity ratio $p = \eta_1/\eta_2$, and passed through a maximum near $p = 1$. When p was less than 0.02 or greater than 11, no secondary drops formed. Secondary drop formation could be suppressed by adding a high concentration of surfactant or by applying an electrostatic field. The experimental results were analysed with reasonable success with the aid of Rayleigh's theory of unstable liquid threads.

532.6 : 551.5

SHAPE OF RAINDROPS. See Abstr. 8434

532.6 : 541.18

PENETRATION OF LIQUIDS IN ABSORBENT SOLIDS. See Abstr. 8336

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

532.7 : 539.2 : 539.12

SOLID AND LIQUID STATE RESEARCH WITH COLD NEUTRONS. See Abstr. 7840

532.7

8646 LAGRANGIAN REPRESENTATION OF A PERFECT FLUID. P.Leruste.
Acta phys. Polon., Vol. 17, No. 1, 3-12 (1958). In French.

It is shown that the Lagrangian formalism represents a perfect fluid provided one makes certain identifications between the classical hydrodynamic quantities and functions of the field quantities. All the equations of Synge can be derived from the Lagrangian theory. T.R.Carson

532.7

8647 CELL-CLUSTER THEORY OF THE LIQUID STATE. V. A TWO DIMENSIONAL FLUID OF HARD SPHERES. E.G.D.Cohen and B.C.Rethmeier.
Physica, Vol. 24, No. 12, 959-69 (Dec., 1958).

For Pt IV see Abstr. 8449 (1957). The cell-cluster theory of the liquid state, developed previously (Abstr. 9465-6 of 1955) is applied here to a two dimensional fluid of hard spheres. The corrections introduced by considering cell-clusters of two cells are investigated. The double cell partition function is calculated in an approximate and an exact way, and the influences on equation of state and entropy are mutually compared. Finally the two results of the cell-cluster theory are compared with the Monte Carlo calculations for a two dimensional fluid of hard spheres by Metropolis et al. (Abstr. 6026 of 1953).

532.7

8648 THE ROTATIONAL KINETIC EFFECT AND THE MOLECULAR STATE OF LIQUIDS. M.Borneas and I.Bâbutia.
C.R. Acad. Sci. (Paris), Vol. 250, No. 9, 1613-14 (Feb. 29, 1960). In French.

The rotational kinetic effect for benzene and water disappears at about 40° C and 60° C, respectively. This is ascribed to a change of the molecular state of the liquid at these temperatures. It is conjectured that the thermal agitation of the molecules prevents their orientation at the higher temperatures (Abstr. 72 of 1960). R.Schnurmann

532.7

8649 PHASE TRANSITIONS IN TWO-COMPONENT SYSTEMS. E.L.Rubin.
Proc. Roy. Soc. A, Vol. 249, 335-45 (Jan. 13, 1959).

The Born–Green equations are generalized to binary mixtures, and solutions in terms of Fourier transforms have been found. The singularities of the solution are believed to correspond to the point at which condensation first occurs in the two component system. A plot of this temperature against density for three mole fractions is shown.

532.7

8650 CLASSICAL THEORY OF THE EQUILIBRIUM LIQUID PAIR DISTRIBUTION. G.H.A.Cole.
Advances in Phys., Vol. 8, 225-51 (July, 1959).

A review of the present state of the theory of the pair distribution in simple liquids. It is emphasized that the "superposition approximation" of Kirkwood is used in some form or another in all existing theories, three of which are developed in some detail: (a) the Born–Green–Yvon integral equation; (b) a more complex, and possibly more accurate, equation formed by taking the second space derivative of the pair distribution instead of the first, as in BGY; (c) a new method in which the intermolecular potential is regarded as being "switched on" gradually from zero by a coupling parameter. The last two methods have not yet been tested numerically. R.O.Davies

532.7 : 534.21

8651 ULTRASONIC VISCOELASTIC PROPERTIES OF ASSOCIATED LIQUIDS.
R.Meister, C.J.Marhoeffer, R.Sciamanda, L.Cotter and T.Litovitz.
J. appl. Phys., Vol. 31, No. 5, 854-70 (May, 1960).

Measurements of ultrasonic propagation of longitudinal and shear waves over a wide frequency and temperature range were made in an homologous series of associated liquids, butanediol 1,3, 2-methyl pentanediol 2,4 and hexanetriol 1,2,6. In each case, the absorption data demonstrated the presence of shear and structural or volume viscosities which are of the order of magnitude and have the same temperature dependence. In order to account for the shear and compressional data, it was necessary to assume that a distribution of relaxation times existed. It was found that a different distribution was necessary for the compressional data. Comparison of the average relaxation time of structural and shear processes in the associated liquids shows that they are very close in value departing by a maximum of a factor of 4. In addition, it was found that the shear modulus was about 20 to 30% of the high-frequency compressional modulus. The ratio of shear compressional modulus in these liquids was very close to the values found in typical solids, even though the magnitudes of the moduli of the liquids was about a factor of 10 smaller than found in typical solids. The temperature dependence of the shear modulus and the relaxation part of the compressional modulus was found to be the same. The moduli linearly increase with decreasing temperature in a manner which is not accounted for by the Eyring-Hirai theory. It was found that the Tobolsky-Leaderman Ferry reduction formula, which is based on the assumption that the moduli are proportional to temperature, does not hold for these liquids and probably not for any high frequency visco-elastic data not associated with an "entropy" modulus. The data in the associated liquids were reduced by using the proper temperature dependence of the moduli. In considering the data of high frequencies, the absorption could not be accounted for by the same distribution which was used to fit the velocity data. At frequencies well above the dispersion region it was found that an attenuation set was independent of frequency. This appears to be characteristic of these liquids at very high frequencies and viscosities. At this time, there seems to be no acceptable mechanism to explain this type of loss. The latter authors have suggested that the hysteresis effect is not related to the viscous flow mechanism causing absorption at the lower frequencies and viscosities.

532.7

8652 INVESTIGATION OF THE VELOCITY AND ABSORPTION COEFFICIENT OF ULTRASOUND IN ETHYL ACETATE WITH A CONSTANT DENSITY. B.I.Kal'yanov and V.F.Nozdrev.
Akust. Zh., Vol. 5, No. 3, 370-1 (1959). In Russian. English translation in: Soviet Physics – Acoustics (New York), Vol. 5, No. 3, 377-9 (Feb., 1960).

Experimental results are given for a density of 0.87 g cm^{-3} ± 1% in the ranges 10 to 33 Mc/s, 20 to 160°C and 70 to about 1000 atm. Results show the significant influence of density on propagation and a relaxation type relation between α/f^2 and frequency. The relaxation frequency (14 ± 1 Mc/s) was independent of temperature.
H.D.Parbrook

532.7

8653 SHOCK HUGONIOTS FOR LIQUID ARGON.
W.Fickett and W.W.Wood.
Phys. of Fluids, Vol. 3, No. 2, 204-9 (March-April, 1960).

Shock Hugoniots for liquid argon are calculated using equations of state obtained from the Monte Carlo method and the Lennard-Jones–Devonshire cell theory, using an experimentally determined pair potential. Agreement with presently available experimental data is poor.

532.7

8654 VAPOUR PRESSURE OF ISOTOPIC LIQUIDS.
G.Boato, G.Scoles and M.E.Vallauri.
Physica, Vol. 24, Supplement, S181 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A study of the dependence on mass of the thermodynamic properties of simple systems at low temperature. Liquid argon in the temperature range between the triple and boiling point was used. Enriched isotopes were not needed, due to the sensitivity and precision of the mass spectrometer used. Tank argon of ordinary purity was used throughout. The ratio of the vapour pressures of A^{36} and A^{40} was found to be 1.0067 ± 0.001 at the triple point, with a temperature coefficient of 0.0002°K.

532.7

8655 ON THE FREE ENERGY OF LIQUID MIXTURES OF ORTHO- AND PARAHYDROGEN.
A.Bellemans and A.Babloyantz.
Physica, Vol. 24, Supplement, S182 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The free energy of a liquid mixture of ortho and para-hydrogen at low temperature has been calculated theoretically by using an Einstein model for the motions of the centre of mass of the molecules. It was found that the stability of the ortho-form is increased in the liquid state, due to: (a) orientational forces; (b) a somewhat larger dispersion energy between pairs of ortho-molecules than between pairs of para-molecules. This conclusion is in agreement with the experimental data.

532.7

8656 DIFFUSION ACROSS THE OIL/WATER INTERFACE.
J.T.Davies and J.B.Wiggill.
Proc. Roy. Soc. A, Vol. 255, 277-91 (April 5, 1960).

Resistances to the diffusion of a third component across an interface separating two liquids may possibly arise from a slow process of re-solvation of the solute, or from a mechanical barrier associated with a film of surface-active additive. With an unstirred diffusion cell of accuracy great enough to detect an interfacial resistance of 1000 sec cm^{-1} the authors showed that neither the clean interface nor various monolayers offer any resistance to the passage of acetic acid or diethylamine between water and oils; polymolecular films, however, may give rise to considerable resistances. All the systems studied show spontaneous emulsification near the interface; the effect of this was analysed quantitatively, and appropriate corrections made to the experimental transfer results. The rate of transfer of solute across a stationary interface is unaffected by the spontaneous emulsion.

532.7 : 539.19

8657 HYDRODYNAMICS OF POLYMER SOLUTIONS. I. DIFFUSION AND SEDIMENTATION OF BRANCHED MOLECULES. O.B.Ptitsyn.
Zh. tekh. Fiz., Vol. 29, No. 1, 75-93 (Jan., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 65-81 (Jan., 1959).

An expression os derived for the friction constant F of branched macromolecules in solution, determining their diffusion and sedimentation. Macromolecules containing one, two and three branch points (with fixed branch lengths and with random length distribution) and ring-shaped molecules are considered. It is shown that F is less sensitive to branching than the root-mean-square radius of inertia $(\overline{R^2})^{1/2}$ for all types of molecule studied, i.e. the proportionality factor P' in the Flory equation $F = P'(\overline{R^2})^{1/2}\eta_0$ (η_0 is the viscosity of the solvent) increases with increasing branching. The value of P' (for a given ratio of the dimensions of a branched and linear macromolecule) is almost independent of the number of branch points in the chain. For strongly branched molecules, the increase of P' relative to its value for linear macromolecules reaches 40% for fixed branch lengths and 30% for a random length distribution. Analysis of experimental data on the sedimentation and molecular dimensions of dextran confirms the theoretical predictions. It is shown that the dimensions and hydrodynamic properties of chains with short appendages are virtually independent (in ideal solvents) of the length and number of appendages.

532.7

8658 PHENOMENA INVOLVED IN THE TRANSPORT PROPERTIES OF PURE FUSED SALTS. A.Klemm.
Z. Naturforsch., Vol. 15a, No. 3, 173-9 (March, 1960). In German.

Transport processes in pure fused salts, liquid metals, etc., are

described by movements of components whose nature remains, in general undetermined. To explain the interactions between the components, there are defined frictional (viscosity) coefficients, effective cross-sections, and degrees of electrolysis, with which are associated diffusion coefficients, conductivities, viscosities, external transport numbers and relaxation times. For simple models with few components (e.g. $NaNO_3$, NaCl, TlCl, and $PbCl_2$) the coefficients may be determined empirically, and the data now reported afford insight into the true nature of the model concerned. It is shown how the external transport numbers may be ascertained from flow resistance at a diaphragm and the maximum electrokinetic rise developed. There are 19 references. H.H.Hodgson

552.7

8659 OSMOTIC MEASUREMENTS WITH SOLUTE-PERMEABLE MEMBRANES. H.Vink.
Ark. Kemi, Vol. 15, Paper 12, 149-69 (1960).

A theory of osmotic measurements with solute-permeable membranes is derived from the principles of irreversible thermodynamics to allow for the time-dependence of transfer due to changing concentrations. The crucial assumption is that the conduction coefficients of the thermodynamic theory are proportional to concentrations. The results of experiments can be analysed in terms of a few flow constants together with the molecular weight distribution of the solvent. The theory is applied to measurements in dilute sodium hydroxide and cupriethylenediamine solutions with a number of oligosaccharides as test substances.
R.O.Davies

532.7

8660 THE HEAT CONDUCTIVITY OF CERTAIN ORGANIC LIQUIDS. V.P.Frontas'ev and M.Ya.Gusakov.
Zh. tekh. Fiz., Vol. 29, No. 10, 1277-84 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1171-8 (April, 1960).

The results of measurements on 22 organic liquids at 20°C using an optical method for the determination of the temperature gradient are presented. The apparatus and method are described in detail. The temperature gradient is given by the change in direction of a monochromatic beam of light in passing through the liquid which is contained between two parallel horizontal planes. The upper plane is the bottom of the heating reservoir and the lower the surface of a calorimeter. 2-3 ml of liquid only is needed and the method is stated to be accurate to within $\pm\frac{1}{2}\%$. Benzene, toluene, nitrobenzene, acetone, chlorobenzene, bromobenzene and carbon tetrachloride are recommended as standard liquids for calibration of thermal conductivity apparatus. S.Weintroub

532.7

8661 ON THE QUESTION OF THE FORMATION OF LIQUID LAMELLAE IN LIQUIDS. A.W.Neumann and P.J.Sell.
Z. phys. Chem. (Leipzig), Vol. 213, No. 5-6, 370-4 (1960). In German.

The more easily formed and the more stable a liquid lens, the smaller is the rate of flow inside the lens. With surface active materials the rate of change of the interfacial tension with concentration is of importance. R.Schnurmann

532.7 : 539.2

8662 COVALENCY IN THE HYDROGEN BOND AND THE PROPERTIES OF WATER AND ICE. H.S.Frank.
Proc. Roy. Soc. A, Vol. 247, 481-92 (Oct. 21, 1958).

Covalency in a hydrogen bond between two water molecules produces a partial charge separation and some rehybridization of the L-shell electrons of the oxygen atom partner. These changes promote the participation of the molecules in additional bond formation which, in turn, stabilizes the original bond. These interactions must be expected to impart a cooperative character to hydrogen-bond formation in liquid water, and it is postulated that the structure of this liquid is characterized by cooperatively bonded flickering clusters of ice-like material surrounded by, and alternating roles with, disordered fluid which makes up the rest of the sample. This assumption offers an explanation for a number of facts, and allows an explanation of the facts that a "diamond" modification of ice is observed at low temperatures and that the c/a ratio in hexagonal ice becomes smaller with rising temperature. The degree of covalency which this explanation presupposes seems to require a modification of the simple Bjerrum (1951) picture of the rotational defects which have been invoked to explain the dielectric properties of ice.

532.7 : 537.2

8663 THE DIELECTRIC CONSTANT OF LIQUID DIELECTRICS IN INTENSE ELECTRIC FIELDS. A DISCUSSION OF THEORY AND EXPERIMENT. A.Piekara.
Acta. phys. Polon., Vol. 18, No. 4, 361-70 (1959). In French.

A short review of dielectric saturation effects in organic liquids of solutions of polar molecules in non-polar solvents. The normal effect is a fall in dielectric constant, However, a rise may be observed as a result of the field-sensitive orientation of pairs of polar molecules, as in nitrobenzene, when it is concentration dependent. Also when there is more than one dipole per molecule with a flexible connection between them, a concentration-independent rise is observed.
J.G.Powles

532.7 : 535.43

LIGHT SCATTERING BY COMMERCIAL SUGAR SOLUTIONS.
See Abstr. 6951

532.7

8664 PRINCIPLE OF A METHOD OF STUDYING THE SORET EFFECT BY PHOTOELECTRIC RECORDING OF THE VARIATION OF THE REFRACTIVE INDEX OF ELECTROLYTIC SOLUTIONS. J.Chanu and F.Parra.
C.R. Acad. Sci. (Paris), Vol. 250, No. 9, 1610-12 (Feb. 29, 1960). In French.

Brief details are given of an interferometric method with photoelectric recording which allows the detection of small variations in refractive index resulting from the thermodiffusion in a cell with a vertical thermal gradient i.e. a pure Soret effect. H.G.Jerrard

532.7 : 539.2

MAXWELL—AMPERE CONFERENCE - LONDON, 1959.
See Abstr. 7829

532.7 : 535 : 539.2

8665 OPTICAL PROPERTIES OF WATER AND ICE IN THE INFRARED AND RADIOWAVE REGIONS OF THE SPECTRUM. L.D.Kislovskii.
Optika i Spektrosk., Vol. 7, No. 3, 311-20 (Sept., 1959). In Russian.

The values of the optical constants (the refractive index n and the absorption factor k) were calculated for water and ice in a wide range of infrared (2.1-3.4 μ) and radiowave (0.01 cm - 1000 km) frequencies. The calculations were based on the author's own model (Abstr. 9105-6 of 1957). Values of n and k at certain wavelengths, some taken from published work and some determined by the author, were used in these calculations. The calculated dependences of n and k on wavelength are shown graphically; they were found to agree well with experimental results reported by others.
A.Tybulewicz

532.7

8666 A TENTATIVE INTERPRETATION OF THE RESULTS OF RECENT X-RAY AND INFRA-RED STUDIES OF LIQUID WATER AND $H_2O + D_2O$ MIXTURES.
C.L.van P.van Eck, H.Mendel and J.Fahrenfort.
Proc. Roy. Soc. A, Vol. 247, 472-81 (Oct. 21, 1958).

An idealized model is proposed for the arrangement of the molecules in water which involves essentially a sixfold coordination of water molecules with four short OH–O hydrogen bonds of ~2.9 A length and two long O–O contacts of ~3.6 A length. An ice-like structure may contribute to a small extent also. This octahedral model has been based on evidence obtained from X-ray and infrared absorption measurements. The model has been found to be in agreement with the density of water and the melting entropy of ice. The reliability of the radial distribution curves W(r) of water obtained from recent X-ray diffraction measurements is discussed. Infrared absorption measurements have been made of liquid HDO in excess D_2O and H_2O, respectively. The respective O–H and O–D stretching vibration frequencies of liquid HDO have been determined. The position (at 3400 cm^{-1}) and shape of the relatively sharp single O–H stretching absorption band of liquid HDO is closely comparable to the corresponding band in liquid interbonding alcohols. The results of the infrared studies indicate an OH–O distance of 2.86 A in water at room temperature.

532.7 : 535.33

8667 SOLVENT EFFECTS ON THE INFRA-RED SPECTRA OF HINDERED PHENOLS. L.J.Bellamy and R.L.Williams.
Proc. Roy. Soc. A, Vol. 254, 119-28 (Jan. 19, 1960).

The effects of variation in the shapes of the solvent and solute

molecules were studied in the hindered phenol series. When a solvent–solute complex is broken by thermal agitation it seems that reassociation of the phenolic OH with another solvent molecule occurs very rapidly. However, the introduction of bulky substituents in the immediate neighbourhood of the OH group lengthens the time between collisions suitably oriented for association. It then becomes possible to detect free OH absorptions corresponding to solute molecules in transit from one colecular association to another. These occur even is such strongly bonding solvents as ethers, and the proportions increase with the complexity of the hindering groups. Similar effects are found when a hindered phenol is examined in a series of solvents of increasing complexity, confirming that there is a dynamic equilibrium between free and associated OH groups. The OH group in the hindered phenols is largely coplanar and only in the 2,6-di-tert.-butyl derivative is there any direct steric hindrance to the approach of the solvent molecule.

532.7 : 535.37 : 539.2

MAXIMUM POLARIZATION OF FLUORESCENCE.
See Abstr. 8018

532.7 : 535.37 : 539.1.07

8668 SCINTILLATION IN HELIUM AT HIGH PRESSURES DUE TO ALPHA-PARTICLES.
S.A.Baldin, V.V.Gabrilovskii and F.E.Chukreev.
J. nuclear Energy, Vol. 8, No. 4, 247-52 (Jan., 1959). English translation of article in: Atomnaya Energiya, Vol. 3, 331 (1957).

A systematic study has been made of the brightness of the light flashes induced in helium and mixtures of helium with other gases by α-particles emitted from polonium. The dependence of the light output on pressure (in the interval of 1-80 atm) and on the concentration of different impurities in the helium (i.e. xenon, neon, nitrogen, oxygen and argon) was also found.

532.7 : 538.27

8669 THEORY OF SPIN–LATTICE QUADRUPOLE RELAXATION [OF NUCLEAR SPINS] IN LIQUID SOLUTIONS OF DIAMAGNETIC SALTS. K.A.Valiev.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 109-17 (July, 1959). In Russian. English translation in : Soviet Physics – JETP (New York), Vol. 37(10), No. 1, 77-82 (Jan., 1960).

Theoretical. The calculations are performed under the assumption that stable complexes are formed around ions, these complexes consisting of molecules of the solvent or of molecules of the solvent and anions (or cations) simultaneously. It is found that lattice relaxation of the nuclear spin of the central ion is due to normal vibrations of the complex if the addends of the complex are identical particles, and by diffuse rotation if the addends are different particles. The calculated magnetic resonance line widths agree with the experimental data for aqueous solutions of Al^{3+} and Ga^{3+} salts. The resonance line widths of weakly hydrated ions (Na^+, Br^-, I^-) are related to the times of stable existence of the corresponding complexes.

532.7 : 538.27

8670 PARAMAGNETIC RELAXATION IN MANGANESE SALT SOLUTIONS. P.G.Tishkov and G.P.Vishnevskaya.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 335-40 (Feb., 1960). In Russian.

Paramagnetic absorption in parallel fields was measured in aqueous manganese salt solutions at concentrations of 0.25 M and higher. It is shown that the thermodynamic theory of paramagnetic relaxation and the Brons–Van Vleck formula are valid for aqueous manganese salt solutions. The spin–lattice relaxation time equals $\sim 10^{-8}$ sec and depends on the nature of the anion and on the concentration of the Mn^{++} ions in the solutions. Its temperature dependence can be described by the Altshuler–Valiev theory. The internal field constants were determined.

532.7 : 538.27

8671 NUCLEAR MAGNETIC RELAXATION IN LIQUID HYDROGEN. T.Moriya.
Progr. theor. Phys., Vol. 18, No. 6, 567-72 (Dec., 1957).

A theory of nuclear relaxation time T_1 in solid H_2 (see Abstr. 8091 of 1960) is extended to the liquid case. In this case, the distinctive feature is the diffusional motion of the molecules ($\tau_c \sim 10^{-12}$ sec) which modulates the anisotropic intermolecular forces. The correlation functions of the rotational angular momentum, $\langle J_+(t)J_-\rangle$, etc..., which appear in the expression for T_1 are calculated by using the Kubo–Tomita formalism for motional narrowing with some simplifying assumptions. The calculated values of T_1 agree with Bloom's (see Abstr. 8754 of 1957) recent measurement in its order of magnitude and the qualitative character of the temperature and the concentration dependence.

532.7 : 538.27

8672 PROTON RESONANCE RELAXATION TIMES IN MOBILE LIQUIDS. J.G.Powles and D.Cutler.
Nature (London), Vol. 184, 1123-5 (Oct. 10, 1959).

Reports measurements of the proton relaxation times T_1 and T_2 in a number of organic liquids and solutions at 25° C. T_1 values are given for 5000 and 250 G. T_2 values are for 0.75 G. T_2 is observed to be significantly smaller than T_1 in many liquids, including water and it is partially marked in benzene solutions. The cause of this difference is discussed. J.G.Powles

532.7 : 539.19

SOLVENT EFFECTS IN NUCLEAR MAGNETIC RESONANCE SPECTRA. See Abstr. 7801

MECHANICS OF GASES

533.1

8673 THE VISCOSITY OF HELIUM.
J.Kestin and W.Leidenfrost.
Physica, Vol. 25, No. 7, 537-55 (July, 1959).

Measurements were made of the viscosity of helium in the pressure range 1-137 atm and in the temperature range 25-237° C, with an accuracy of from 0.2% at lower temperatures to 0.5% at higher temperatures. The method used was that of a disk oscillating between two plates with moderate gaps, and the measurements were relative to nitrogen. The results show no significant pressure effect. The temperature effect has been correlated empirically by the use of Keesom's and Keyes' formulae as well as by the use of the methods of statistical mechanics, i.e. with the aid of the Lennard-Jones, 6-12, and the modified Buckingham, exp. 6 potentials. It appears that the best fit is obtained with the aid of the exp. 6 potential. If an accuracy of 1% only is required, then there is little to choose between the various schemes up to 800° C. Keesom's formula spans the widest range of temperatures.

533.1

8674 VISCOSITY OF FLUID ARGON UNDER CONDITIONS OF CONSTANT DENSITY. R.Scott.
Physica, Vol. 24, Supplement, S181 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The falling plug method has been used in measurements of the viscosity of fluid argon under conditions of essentially constant volume over a range of temperatures and pressures. This method of viscometry has been investigated, and a criterion for changeover from central to side-of-tube fall has been established. For central fall, a relation has been found between the dimensions of the apparatus, densities of plug and fluid, speed of plug fall, and the viscosity of the fluid medium.

533.1

8675 VISCOSITY OF GAS MIXTURES.
A.O.Rietveld and A.van Itterbeek.
Physica, Vol. 24, Supplement, S180 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The viscosity of several mixtures of hydrogen isotopes and noble gases has been measured by means of the oscillating disc method in the temperature range 20 to 300° K. An analysis of the results for the isotopic mixtures shows the increasing influence of quantum mechanics at lower temperatures. The results at higher temperatures can be described rather well with calculations based on a Lennard–Jones potential.

533.1

8676 THE EFFECT OF PRESSURE ON THE VISCOSITY OF N_2–CO_2 MIXTURES. J.Kestin and W.Leidenfrost.
Physica, Vol. 25, No. 7, 525-36 (July, 1959).

Precise measurements of the viscosity of the binary mixture N_2–CO_2 were made at 20° C over a range of pressures from 1 to 21 atm. The viscosity was measured with the aid of an oscillating-disk viscometer developed by the authors. The measurement was an absolute one with an estimated accuracy of 0.05%. The composition of the mixtures was determined from the measured pressures

during filling with the aid of the Benedict–Webb–Rubin equation. It is believed that the molar fractions were determined with an uncertainty of 1%. This is by far the largest uncertainty of the measurements. The pressure effect on the viscosity of the pure components at 20° C was determined in the same instrument leading to internally consistent data. A comparison is made with Wilkes' equation (Abstr. 5589 of 1950) for the viscosity of binary mixtures

533.4

8677 PRIMARY STANDARD BAROMETER OF RANGE 0 TO 1200 mb.

K.W.T.Elliott, D.C.Wilson, F.C.P.Mason and P.H.Bigg.
J. sci. Instrum., Vol. 37, No. 5, 162-6 (May, 1960).

A primary standard barometer covering all pressures in the range 0 to 1200 mb has been designed and constructed at the National Physical Laboratory. A feature of the instrument is the use of optical probes (Abstr. 9024 of 1957) as fiducial indicators which assess, from overhead, the positions of 11 cm diameter mercury surfaces in the barometer U-tube, thus permitting the mercury columns to be fully waterjacketed. The two probes use a single mercury pool as a common reference surface and their movements are assessed in terms of readings on associated line standards of Invar by means of fixed micrometer microscopes. The U-tube assembly is supported on an anti-vibration mount. The accuracy of height measurement of barometric columns was estimated by reference to measurements on end-gauges mounted in the empty U-tube and found to be better than 0.003 mm (standard deviation). Taking into account the small uncertainties in mercury density and local gravity the overall accuracy of a single pressure measurement is estimated to be about ± 0.01 mb on a 99% certainty basis. At about 1000 mb, check comparisons with N.P.L. primary barometers of earlier design support this assessment.

533.6 : 532.5

8678 HYDRAULIC ANALOGUE FOR ONE DIMENSIONAL UNSTEADY GAS DYNAMICS. W.H.T.Loh.

J. Franklin Inst., Vol. 269, No. 1, 43-55 (Jan., 1960).

Observations on water waves in open horizontal channels of specially designed sections can in principle be used to study waves of compression in gases in a duct, because the equations of non-steady motion in the two cases can be cast in the same mathematical form. J.G.Oldroyd

533.6

8679 STABILITY OF AN IDEALIZED ATMOSPHERE. I. DISCUSSION OF RESULTS. K.M.Case.

Phys. of Fluids, Vol. 3, No. 2, 149-54 (March-April, 1960).

The stability of an idealized atmosphere with constant shear flow and exponentially decreasing density is considered. In no case does an initial perturbation increase with time. The decrease is, in general, not faster than a small fractional power of the time.

533.6

8680 STABILITY OF AN IDEALIZED ATMOSPHERE. II. ZEROS OF THE CONFLUENT HYPERGEOMETRIC FUNCTION. F.J.Dyson.

Phys. of Fluids, Vol. 3, No. 2, 155-7 (March-April, 1960).

It is proved that the confluent hypergeometric function $W_{k,m}(z)$ has no complex zeros when the index k is real while m is pure imaginary. Under these conditions, there is an infinite set of positive real zeros with a point of accumulation at zero. The zeros of $W_{k,m}(z)$ are related to the stability of a model incompressible atmosphere, with density decreasing exponentially and horizontal wind velocity increasing linearly with height. The nonexistence of complex zeros indicates that this model atmosphere should be stable. The stability is rigorously proved in Pt I.

533.6

8681 EXACT SOLUTIONS FOR THE ONE-DIMENSIONAL VISCOUS FLOW OF A PERFECT GAS. G.Rosen.

Phys. of Fluids, Vol. 3, No. 2, 191-6 (March-April, 1960).

Velocity-free equations are derived for the unsteady one-dimensional real fluid flow of a perfect gas. These equations admit a pressure-time symmetry, a stress symmetry, and a displacement symmetry. Fundamental solutions associated with each of the three symmetries are reported.

533.6

8682 A STUDY OF THE INITIAL SECTION OF A TURBULENT JET OF COMPRESSED AIR. S.A.Ershin and Z.B.Sakipov.

Zh. tekh. Fiz., Vol. 29, No. 1, 51-60 (Jan., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 43-51 (Jan., 1959).

Describes experiments on both non-isothermal jets (heated compared with the surrounding medium) and on isothermal mixing of a jet of hydrogen with atmospheric air. Brief details are given of the experimental arrangements. The results which are shown graphically, together with those of previous studies, confirm the hypothesis that there is a universal law governing the flux density of excess heat content in the initial section of a free axially symmetrical turbulent jet of gas. S.Weintroub.

533.6

8683 THE TURBULENT BOUNDARY LAYER ON A FLAT PLATE IN A UNIFORM STREAM OF A COMPRESSIBLE FLUID. S.I.Kosterin and Yu.A.Koshmarov.

Zh. tekh. Fiz., Vol. 29, No. 7, 906-15 (July, 1959). In Russian. English Translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 7, 819-26 (Jan., 1960).

An attempt is made to investigate the effect of a density fluctuation on the distribution of velocity, of temperature, and of density in the boundary layer, and therefore, on friction and heat exchange. Turbulent mixing is represented according to Prandtl's diagram. A method of calculation is developed which gives results in satisfactory agreement with experiment. The effect of density fluctuations is significant when the M-numbers and the heat exchange are large. Comparison of the results calculated by two methods (with and without accounting for density fluctuations) shows that when the M-numbers are >6, the difference in the friction coefficients is from 15 to 40% of the values calculated by the method in which the density fluctuation is not taken into account (according to the region investigated in terms of $Re\theta_w$).

533.6 : 534.23

8684 ACOUSTIC RADIATION FROM A TURBULENT FLUID CONTAINING FOREIGN BODIES. P.E.Doak.

Proc. Roy. Soc. A, Vol. 254, 129-45 (Jan. 19, 1960).

The problem of the acoustic radiation from a turbulent fluid containing foreign bodies of arbitrary shape and arbitrary composition is solved formally by the method of Green functions. Particular attention is given to the radiation from the surface of these bodies. A practical advantage of the method is that provided an appropriate Green function can be found, either exactly or approximately, then knowledge of the values on the surface of the fluctuations in only one scalar variable is needed to permit estimation of the radiation from the surface. This variable may be either the pressure, the normal density gradient. The pressure fluctuations at the surface, in particular, are relatively easy to measure. It is shown that if fluctuations in the fluid are locally isentropic the volume source distribution of the pressure fluctuations is quadrupole. A proof is given of the proposition that when arbitrary obstacles are immersed in a fluid all dipole radiation must come from surface source distributions on these obstacles. For rigid bodies these distributions represent physically the reaction by the obstacles to the stresses imposed upon them by the fluid. It is proved that if the density fluctuations or the normal density gradient fluctuations on these surfaces vanish then there is no dipole radiation. The same result is true for pressure and pressure gradient fluctuations within the limits of validity of the assumption of local isentropy. A brief description is given, together with references to more detailed accounts, of some of the principal features of the behaviour of Green functions which may be useful in practical estimates of aerodynamic surface sound. As a representative example of acoustic radiation from a turbulent boundary layer, the total acoustic power radiated by a turbulent boundary layer on an infinite rigid plane is estimated, using the limited available experimental data on wall pressure fluctuations. For low and moderate subsonic speeds the power radiated per unit wall area covered by the turbulent boundary layer is $K\rho_0 a_0^3 M_0^5$, where M_0 is the free stream Mach number, ρ_0 is the density and a_0 the speed of sound in the undisturbed fluid, and the dimensionless parameter K is approximately a constant of order of magnitude 10^{-3}.

533.6 : 551.5

8685 HEAT TRANSPORT ANEMOMETER OF HIGH STABILITY. A.J.Dyer.

J. sci. Instrum., Vol. 37, No. 5, 166-9 (May, 1960).

An anemometer is described based on the principle of detecting the wake behind a heated wire by means of a thermometric bridge. An earlier design of this type of anemometer required a servo-amplifier having a gain of 10^6 times. A new principle enables the

the desirable features of the former method, namely linearity and unidirectivity, to be preserved with an amplifier gain of 80 times with a corresponding improvement in stability and simplicity. The measured response time of the instrument is approximately 0.1 sec.

533.6

8686 CENTRIPETAL AIR-PUMP OPERATED ELECTROMAGNETICALLY. B.Popper and M.Reiner.
Brit. J. appl. Phys., Vol. 10, No. 1, 54-5 (Jan., 1959).

An instrument has been constructed to show that during the shearing of gas (air) a cross-pressure is developed and that the air moves centripetally towards the centre. E.G.Knowles

GASEOUS STATE

533.7 : 530.16

8687 ON THE APPROACH TO EQUILIBRIUM OF QUANTUM GASES. I.Prigogine and P.Resibois.
Physica, Vol. 24, Supplement, S169 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The approach to equilibrium of a homogeneous quantum gas is studied. The concentration was assumed sufficiently low for the equilibrium properties to be described by a perfect Bose–Einstein (or Fermi–Dirac) gas. Starting from the formal solution of the Von Neumann equation and using diagram techniques, a transport equation is derived; the transition probabilities are complex functions of the occupation numbers when realistic interactions (like hard sphere interactions) are used. In this way, apart from the well known terms of the Uhlenbeck-Uehling type, describing the effect of the statistics on the final states, new terms due to symmetry effects in the intermediate states are found. This formalism is used to study the problem of singularities in the transport properties at the λ-point.

533.7

8688 ON THE RANDOM MOTIONS OF THE MOLECULES IN A GAS. II. C.Christov.
Acta. phys. Hungar., Vol. 7, No. 1, 51-66 (1957). In German.

Some applications of the formulae derived in Pt I (Abstr. 6948 of 1957) are given. An exact expression for the average acceleration of a molecule with a given initial velocity is given. In addition an expression is determined for the coefficient of self diffusion; a formula is given which enables the transition probability at long time intervals to be calculated; and finally expressions are given for the dispersion and average displacement of the molecules.
W.J.Orville-Thomas

533.7

8689 CALCULATION OF THE MUTUAL FRICTIONAL FORCE IN A GASEOUS "TWO-FLUID" MODEL.
P.Glansdorff.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 6, 575-82 (1959). In French.

The model considered is of a two-constituent gas mixture, in which exchanges of momentum between unlike particles are much less important than those between like particles. The frictional force due to this small coupling is given as an infinite series, of which the first terms are calculated. J.Hawgood

533.7 : 536.42

"LATTICE" MODEL OF A GAS. See Abstr. 6992-3

533.7

8690 A DYNAMIC HARD SPHERE MODEL. D.Turnbull and R.L.Cormia.
J. appl. Phys., Vol. 31, No. 4, 674-8 (April, 1960).

A simple two-dimensional model, in which uniform hard spheres are made to move steadily and apparently nearly at random, is described. At low sphere density the model exhibits "gas-like" behaviour. As the density is increased the behaviour becomes more "liquid-like" and then "crystallization" occurs. Many dynamic atomic phenomena, believed to occur in the gas, liquid, or solid state, are illustrated by the model.

533.7

8691 INTERMOLECULAR FORCES AND PROPERTIES OF FLUIDS. I. THE AUTOMATIC CALCULATION OF HIGHER VIRIAL COEFFICIENTS AND SOME VALUES OF THE FOURTH COEFFICIENT FOR THE LENNARD-JONES POTENTIAL. S.F.Boys and I.Shavitt.
Proc. Roy. Soc. A, Vol. 254, 487-98 (March 8, 1960).

The prediction of the virial coefficients for particular intermolecular potentials is generally regarded as a difficult mathematical problem. Methods have only been available for the second and third coefficient and in fact only few calculations have been made for the latter. Here a new method of successive approximation is introduced which has enabled the fourth virial coefficient to be evaluated for the first time for the Lennard-Jones potential. It is particularly suitable for automatic computation and the values reported here have been obtained by the use of the EDSAC I. The method is applicable to other potentials and some values for these will be reported subsequently. The values obtained cannot yet be compared with any experimental results since these have not been measured, but they can be used in the meantime to obtain more accurate experimental values of the lower coefficients.

533.7

8692 INTERMOLECULAR FORCES AND PROPERTIES OF FLUIDS.II. A GENERAL FUNCTIONAL REPRESENTATION OF INTERMOLECULAR POTENTIALS, AND SOME VALUES OF THE SECOND, THIRD AND FOURTH VIRIAL COEFFICIENTS FOR SYSTEMATICALLY DIFFERING POTENTIALS. S.F.Boys and I.Shavitt.
Proc. Roy. Soc. A, Vol. 254, 499-506 (March 8, 1960).

A new functional representation of angle-independent intermolecular potentials is described, having an unlimited number of parameters in the form of linear coefficients in an expansion depending on a complete system of functions. The basic single-term form of this function is practically equivalent to the Lennard-Jones (6-12) potential. Three particular examples of this potential, having different widths of the potential well, have been examined, and the second, third, and fourth virial coefficients for them have been calculated for a number of temperatures. It is shown that the new functional representation should enable better and more systematic progress in the estimation of intermolecular potentials to fit experimental data.

533.7 : 523.84

8693 SHOCK RELATIONS IN A FERMI–DIRAC GAS. P.Lal and P.L.Bhatnagar.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 1, 9-15 (1957).

When an element of mass crosses a shock wave, discontinuous changes are produced in its physical and dynamical variables. Rankine and Hugoniot relations determine the jumps in these variables for a perfect gas. The matter of which stars are composed ranges from perfect gas to degenerate gas. Hence the relations corresponding to Rankine–Hugoniot relations for a perfect gas have been obtained to determine the jumps in the physical and dynamical variables for a Fermi–Dirac gas. The perfect gas and the degenerate gas form the two limiting cases of a Fermi–Dirac gas. For these two limiting cases these jumps have been obtained in an explicit form as functions of Mach number of the incoming flow, while for the intermediate range a numerical method is indicated for determining them.

533.7

8694 SONIC ABSORPTION IN CARBON DISULFIDE VAPOR AS A FUNCTION OF TEMPERATURE. J.C.Gravitt.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 560-4 (May, 1960).

The thermal relaxation absorption in carbon disulphide vapour at a temperatures between 0° and 160°C was obtained for frecuencies between 50 kc/s and 4 Mc/s per sec per atm. The data were obtained by the tube method. The relaxation time, the transition probability, and the collision efficiency were determined as a function of temperature from the measured data. The collision efficiency as a function of temperature is adequately predicted by the Landau and Teller theory. (1936).

533.7

8695 MEASUREMENTS ON THE VELOCITY OF SOUND IN ARGON UNDER HIGH PRESSURE.
A.van Itterbeek, W.van Dael and W.Grevendonk.
Physica, Vol. 25, No. 7, 640-4 (July, 1959).

Michels, Levelt and Wolkers (Abstr. 3407 of 1959) calculated

the variation of the velocity of sound in argon gas as a function of pressure and temperature from their direct experimental data on the equation of state of argon. Direct measurements are reported on the velocity of sound and were found to be in good agreement with the calculated values. The change of the velocity of sound as a function of pressure in liquid argon was measured at the boiling point of liquid oxygen. A linear variation was found.

533.7

8696 THERMAL DIFFUSION OF XENON AT TRACER CONCENTRATIONS. D.Heymann and J.Kistemaker.
Physica, Vol. 25, No. 7, 556-68 (July, 1959).

Numerical values of thermal diffusion factors are a prerequisite for the discussion of thermal diffusion columns. They can be calculated by theory using the Lennard-Jones 6-12 model and appropriate force constants. The validity of theory at low concentrations has been proved in few cases only. A "two-bulb technique" has been applied here to measure $\alpha(T)$ of the systems Xe–He, Xe–H_2, Xe–D_2, Xe–Ne, Xe–N_2 and Xe–A in the temperature range of 300-700°K. Radioactive Xe^{133} was used as a tracer. Experimental results show that the quantitative agreement between theory and experiment is good. In the case of Xe–H_2, Xe–D_2 and Xe–N_2 the measured thermal diffusion factor is larger than the predicted thermal diffusion factor by 5-10%. The limiting value of R_T is about 0.50 for these systems which is definitely smaller than R_T values of 0.65 that have been previously measured in aequimolar mixtures of Xe–He, Xe–Ne and Xe–A. The accuracy of the measurements is mainly limited by the corrections implied in the Geiger–Müller counting technique and is of the order of 5%.

533.7

8697 THE MEASUREMENT OF THE MUTUAL DIFFUSION COEFFICIENT OF GASES BY AN [ABSOLUTE] OPTICAL METHOD. P.E.Suetin, G.T.Shchegolev and R.A.Klestov.
Zh. tekh. Fiz., Vol. 29, No. 8, 1058-64 (Aug., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 8, 964-9 (Feb., 1960).

The apparatus (comprising a light source, condenser, grating, objective, diffusion tubes, grating, collimeter and photomultiplier, in that order) and its application are described. Results are given for the following pairs of gases: H_2–He, H_2–air, H_2–CO_2, He–air, and He–CO_2. An accuracy of up to 3% is claimed. A significant improvement on this can be achieved by using an objective with a longer focal length.

533.7

8698 THE ISOTHERMALS OF BENZENE VAPOUR BETWEEN 22 AND 70°C.
G.A.Bottomley, C.G.Reeves and R.Whytlaw-Gray.
Proc. Roy. Soc. A, Vol. 246, 504-12 (Aug. 26, 1958).

The deviations of benzene vapour from ideality have been studied in a differential compressibility apparatus with nitrogen as the reference gas. Measurements have been taken at 22, 35, 50 and 70°C and over a wide range of pressures up to about 80% saturation at each temperature. Corrections have been made for the adsorption of the vapour on the Pyrex glass surfaces and on the mercury.

533.7

8699 THE SECOND VIRIAL COEFFICIENT OF BENZENE AT LOW PRESSURES.
G.A.Bottomley, T.A.Remmington and R.Whytlaw-Gray.
Proc. Roy. Soc. A, Vol. 246, 514-20 (Aug. 26, 1958).

The density of benzene vapour at about 7% saturation at 22°C has been determined experimentally by the microbalance method using nitrogen as the comparison gas. The adsorption of the benzene vapour on the particular working parts of the two balances used in the work was determined in separate experiments, so that full correction of the density determinations for this influence was possible. The second virial coefficient of the vapour has been deduced at 22°C and, from similar measurements, at 35°C.

533.7

8700 VAPOR PRESSURES OF THE NEON ISOTOPES. E.G.Roth and J.Bigeleisen.
J. chem. Phys., Vol. 32, No. 2, 612 (Feb., 1960).

Measured over the temperature range 16.4°-30.1°K by differential manometry in a Giauque-Johnston type cryostat modified for temperature stability. The Ne^{20} sample used contained 99.9% Ne^{20} and the Ne^{22} sample contained 72.2% Ne^{22}. The results are substantially in agreement with those of Keesom and Haantjes (Abstr. 5122 of 1935). For solid neon the data can be accurately represented by an Einstein or Debye harmonic lattice with θ_D (Ne^{20}) = 74.6°K.
H.C.Cole

533.7

8701 THE SECOND VIRAL COEFFICIENTS OF MIXED POLAR VAPOURS. J.D.Lambert, J.S.Clarke, J.F.Duke, C.L.Hicks, S.D.Lawrence, D.M.Morris and M.G.T.Shone.
Proc. Roy. Soc. A, Vol. 249, 414-26 (Jan. 13, 1959).

The second virial coefficients of binary mixtures of chloroform with methyl formate, n-propyl formate, methyl acetate, ethyl acetate and diethylamine have been measured in a Boyle's law apparatus at temperatures between 50 and 95°C. The measured values are consistently higher that predicted by the theory of corresponding states, and a quantitative interpretation is proposed, based on the hypothesis that the esters and amine are partially dimerized and are involved in association with the chloroform by hydrogen bonding. A linear relation is shown to exist between the heats and entropies of association for the various mixtures, and the theoretical significance of this is discussed. There is some evidence that hydrogen bonds are formed through the alkoxyl oxygen by formate esters and through the carbonyl oxygen by acetate esters. The paper includes data on the second virial coefficient for the pure esters and for ethyl formate and methyl propionate.

533.7

8702 MUTUAL DIFFUSION OF BINARY MIXTURES OF HELIUM ARGON AND XENON AT DIFFERENT TEMPERATURES. K.P.Srivastava.
Physica, Vol. 25, No. 7, 571-8 (July, 1959).

The coefficient of mutual diffusion of the binary gas mixtures A–He, A–Xe and He–Xe has been determined at 0°, 15°, 30° and 45°C by allowing the diffusion to take place between two bulbs through a precision capillary tube. A differential conductivity analyser has been used to analyse the samples of the gas withdrawn from one of the bulbs at different times. These experimentally determined diffusion coefficients have been utilized for calculating the unlike potential parameters ϵ_{12}/k and σ_{12} on the Lennard-Jones 12 : 6 model and compared with the values obtained previously from thermal diffusion data and also from the usual combination rules. The agreement seems to be quite satisfactory. These experimentally determined values of ϵ_{12}/k and σ_{12} have been further used for calculating D_{12} and are found to reproduce the experimental data satisfactorily.

533.7

8703 THE VISCOSITY OF GASEOUS HD BELOW 80°K. J.M.J.Coremans, A. van Itterbeek, J.J.M.Beenakker, H.F.P.Knaap and P.Zandbergen.
Physica, Vol. 24, No. 12, 1102-4 (Dec., 1958).

Data are given for the coefficient of viscosity of HD below 80°K. These results are compared with predictions based on a quantum-mechanical modification of the law of corresponding states.

533.7 : 536.48

8704 THE EQUATION OF STATE OF GASES AT LOW TEMPERATURES. J.De Boer.
Physica, Vol. 24, Supplement, S90-S97 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. of 1960). The theoretical expressions for the pressure and the energy of a quantum system expanded in a power series of powers of the density are discussed. The various types of intermolecular fields: the 12-6 potential, the exp 6 potential and the exp 6-8 potential, which are in use to evaluate the exact theoretical expressions are compared. At low temperatures only gaseous helium (He^3 and He^4) and hydrogen (H_2, D_2, HD and the ortho-para varieties) are of interest. Calculations made by different groups of investigators are examined and compared in order to obtain satisfactory information about the molecular interaction curve. A close relation exists with the theoretical expressions for the low density limit of the transport coefficients.

533.7

8705 THE QUANTUMMECHANICAL MODIFICATION OF THE LAW OF CORRESPONDING STATES FOR THE VISCOSITY OF SIMPLE GASES AT LOW TEMPERATURES.
J.M.J.Coremans, J.J.M.Beenakker, A.van Itterbeek and H.F.P.Knaap.
Physica, Vol. 24, Supplement, S167 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Viscosity measurements of

He^3, He^4, H_2, D_2 and Ne between 20 and 80°K are discussed in terms of a quantum-mechanical modification of the law of corresponding states. The existing data can be described in terms of a series in the De Broglie parameter. The leading term of this series development is determined from the experimental data.

533.7

8706 THE DIFFERENCE IN THE SECOND VIRIAL COEFFICIENT IN THE EQUATION OF STATE BETWEEN THE ORTHO AND PARA MODIFICATIONS OF H_2 AND D_2.
J.J.M.Beenakker, F.H.Varekamp and H.F.P.Knaap.
Physica, Vol. 24, Supplement, S167 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Using a differential method measurements were performed on the difference in the second virial coefficient of the equation of state for the ortho and para modifications of H_2 and D_2 at liquid hydrogen temperatures. For H_2 at 20°K a difference of the order of 1% was found, the second virial coefficient of ortho hydrogen having the larger absolute value. The temperature dependence was measured down to 17°K. For deuterium no measurable effect was found.

533.7

8707 NON IDEAL MIXING OF GASES AT LOW PRESSURES AND LIQUID HYDROGEN TEMPERATURES.
F.H.Varekamp and J.J.M.Beenakker.
Physica, Vol. 24, Supplement, S167 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A method was developed to determine the deviation from ideal mixing of gases at low temperatures. The deviation of the contribution to the second virial coefficient due to interaction of dissimilar molecules, B_{12}, from the ideal mixing assumption: $B_{12} = \frac{1}{2}(B_{11} + B_{22})$ is determined directly. Preliminary measurements on H_2–He mixtures at liquid hydrogen temperatures are reported.

533.7

8708 RECENT INVESTIGATIONS ON THE THOMSON–JOULE EFFECT OF GASES AND GASEOUS MIXTURES.
W.Koeppe.
Physica, Vol. 24, Supplement, S167-S168 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: New measurements are communicated on the integral Thomson–Joule effect ΔT of some N_2–H_2, N_2–A, and A–O_2 mixtures at room temperatures and at pressures up to 120 atm. An expression is given for ΔT, which can be modified for gaseous mixtures. The first term of this formula contains μ_0, the Thomson–Joule coefficient at zero pressure. μ_0 was determined with the aid of the Lennard-Jones 6,12 potential, taking into account quantum corrections for the light gases. All measured values of μ_0 of pure gases and of gaseous mixtures could be adjusted to theory. The further terms of the formula for ΔT were determined from the measured values of ΔT. By this procedure the old theorem of corresponding states could be shown to be not valid. It must be replaced by an extended theorem (in the sense of Pitzer and Riedel). Because of the incompleteness of the experimental data, no general rules can be given about this.

533.7

8709 PHASE EQUILIBRIA COMPOSITIONS OF MIXTURES OF CARBON DIOXIDE, OXYGEN, AND NITROGEN.
L.I.Dana and G.H.Zenner.
Physica, Vol. 24, Supplement, S168 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: In these experiments, the equilibrium compositions of liquid and vapour phases of the binary mixtures CO_2–O_2, and CO_2–N_2 were determined at all temperatures and pressures where the two phases were coexistent. Data were taken at 0°C, −40.3°C and −55.0°C and at pressures over the range of vapour pressure of pure CO_2 to the critical pressure of the mixture. Data were obtained for the ternary mixtures CO_2–O_2–N_2 at 0°C, −40.3°C and −55.0°C at pressures varying from 50 to 129 atm absolute. Finally, the variation of the freezing point of CO_2 liquid when saturated with N_2 at various pressures was ascertained.

533.7

8710 ON THE EQUILIBRIUM OF THE GASEOUS AND SOLID PHASES OF THE SYSTEM HYDROGEN–METHANE.
W.A.J.Versteegen and Z.Dokoupil.
Physica, Vol. 24, Supplement, S168 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The equilibrium between the gaseous and solid phases of the system H_2–CH_4 has been examined in the region of temperatures from 90°K down to 55°K and at pressures of 5, 10 and 15 atm. In this temperature region the solid phase consists only of methane. To determine the concentration of methane in the gaseous phase the flow method was applied; the analysis of the corresponding gaseous sample was performed by freezing out the methane at 20°K. As the triple point of methane (90.15°K) is appreciably higher than the triple point of N_2 and O_2 and these gases as possible impurities in methane are much more soluble in gaseous hydrogen under the same experimental conditions, special attention has been taken with respect to the purity of methane and hydrogen. The results are plotted in a T versus x diagram. The macroscopic description of the examined equilibrium of the system H_2–CH_4 in the above mentioned p–T region can be, in fact, achieved by using any equation of state for a gaseous mixture, provided it leads to a reasonable value of the first virial coefficient B. The agreement of theory and experiment is then satisfactory. The results give sufficient information of the behaviour of the system H_2–CH_4 for the purification of hydrogen contaminated by methane.

533.7 : 536.2

8711 AN EXPERIMENTAL INVESTIGATION OF THE HEAT CONDUCTIVITY OF MONATOMIC GASES OVER WIDE TEMPERATURE INTERVALS. L.S.Zaitseva.
Zh. tekh. Fiz., Vol. 29, No. 4, 497-505 (April, 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 444-50 (April, 1959).

The hot wire method with a 0.1 mm diameter Pt wire was used to measure the heat conductivity of He, Ne, A, Kr and Hg vapour at temperatures up to approximately 500°C. The apparatus and results are fully described. The values of the coefficient ϵ in $\lambda = \epsilon\eta C_V$, where λ, η and C_V are the heat conductivity, viscosity and specific heat at constant volume, respectively, were calculated from the experimental data and it is shown by a graphical method that $1/\epsilon = B_0 + B_1(1/T)$. S.Weintroub

533.7 : 536.42

8712 ON EVAPORATION OF DROPLETS IN ROCKET MOTOR CHAMBER. M.S.Sodha and V.K.Jain.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 3, 143-9 (1957).

In this paper, the authors have discussed the problem on the lines of Penner and Hartwig (1953) and on the basis of the expression for a rate of evaporation, due to Maxwell and Langmuir. The results have been obtained in a much more neat and convenient form as compared to the simultaneous numerical solution of two resulting differential equations of Penner and Hartwig.

533.7 : 537.2

8713 THE LORENTZ–LORENZ FUNCTIONS OF ARGON, NITROGEN AND CARBON DIOXIDE UP TO 50 ATMOSPHERES AT A WAVELENGTH OF 12 mm.
H.W.de Wijn and F.W.Heineken.
Physica, Vol. 25, No. 7, 615-25 (July, 1959).

The Lorentz–Lorenz functions of argon, nitrogen and carbon dioxide have been measured at room temperature and at pressures up to 50 atm. The measurements have been performed at a frequency of 25 Gc/s with the aid of a long cylindrical cavity. The Lorentz–Lorenz functions of the investigated gases show an increase with increasing density. For argon the relative increase amounts to (0.25 ± 0.2)% at a density of 40 Amagats, for nitrogen to (0.36 ± 0.2)% at 40 Amagats and for carbon dioxide to (1.8 ± 0.3)% at 50 Amgats, the increases being referred to the values at normal temperature and pressure. Supplementary measurements with an other apparatus show the Lorentz–Lorenz functions to be constant up to densities of about 2 Amagats within an experimental error of 0.05%. The results are compared to the results predicted by the existing theories.

533.7 : 535.33 : 534.23

8714 THE SENSITIVITY THRESHOLD OF AN OPTICO-ACOUSTIC RADIATION RECEIVER. III. THE GENERAL CASE OF A NON-CYLINDRICAL SELECTIVE RECEIVER CHAMBER. A.O.Sall'.
Optika i Spektrosk., Vol. 7, No. 3, 432-6 (Sept., 1959). In Russian.

For previous parts, see Abstr. 969-70 1960. Deduces formulae for determination of the numerical value of the sensitivity threshold of a selective optico-acoustic receiver of radiation whose receiver chamber is of complex form. The following receiver-chamber shapes

are considered: cylindrical, hemispherical, truncated 90° cone and a circular groove of triangular cross-section. Examples of calculation of the receiver-chamber depth are given. A.Tybulewicz

533.7 : 535.3 : 534.23

8715 THE OPTICO-ACOUSTIC EFFECT IN THE ULTRAVIOLET REGION OF THE SPECTRUM. Ya.I.Gerlovin.
Optika i Spektrosk., Vol. 7, No. 4, 571-2 (Oct., 1959). In Russian.

Generation of acoustic waves on absorption of modulated ultraviolet radiation by nitrogen, oxygen and acetylene gases in a closed chamber (the optico-acoustic effect) is reported. A.Tybulewicz

533.7 : 535.33

8716 GLOW DISCHARGE SPECTRA OF COPPER AND INDIUM ABOVE AQUEOUS SOLUTIONS.
D.E.Couch and A.Brenner.
J Electrochem. Soc., Vol. 106, No. 7, 628-9 (July, 1959).

The glow discharge between a tungsten anode and the solution shows visible and ultraviolet spectra of Cu, CuH, In, and InCl. This is attributed to the formation of volatile compounds of these elements, since other metal salts in solution do not show the effect.
G.F.Lothian

533.7 : 535.33

8717 ABSORPTION BY INFRARED BANDS OF CARBON DIOXIDE GAS AT ELEVATED PRESSURES AND TEMPERATURES. D.K.Edwards.
J. Opt. Soc. Amer., Vol. 50, No. 6, 617-26 (June, 1960).

Experimental data and empirical correlations for the total absorption of band groups at 15, 10.4, 9.4, 7.5, 5.2, 4.8, 4.3, 2.7, 1.6, and 1.4μ are presented for carbon dioxide gas in nitrogen at total pressures from 0.5 to 10 atm, temperatures from 294° to 1390°K (530° to 2500°R) and mole fractions from 0.05 to 1.00. The data were obtained from low-resolution measurements of the spectral absorptivity. Use of optical paths of 129 cm at 294°K and 38.8 cm at that and higher temperatures resulted in a range of mass path lengths from 10 to 24 500 g/m^2.

533.7 : 535.33

8718 SELECTIVE RADIATORS.
G.N.Plass.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1442-7 (Sept., 1959).

The physical processes and mathematical equations which describe the absorption and emission of radiation by gases are presented. The emission from a single line is discussed first, and then the influence on the emission of various arrangements of spectral lines into bands is considered. Some examples of emission from flames are given. C.Hilsum

533.7 : 538.27 : 530.16

8719 THE STUDY OF QUANTUM STATISTICAL MECHANICAL EFFECTS IN GASES USING NUCLEAR MAGNETIC RESONANCE TECHNIQUES. M.Bloom and I.Oppenheim.
Physica, Vol. 24, Supplement, S158 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The observed linear relationship between t_1 (spin-lattice relaxation time) and density for protons in hydrogen gas (Abstr. 8754 of 1957) at constant temperature may be explained in terms of an extension of Moriya's theory (Abstr. 8671 of 1960) of t_1 in liquid H_2 to the gas. In this theory, the linear relationship is obtained in a region in which the radial distribution function g(R) is independent of density, i.e. in the region in which only binary collisions are important. Quantum mechanical considerations, however, lead one to expect deviations from linearity even when 3-body collisions are unimportant, if the mean de Broglie wavelengths of the molecules become comparable with their effective sizes. The order of magnitude of these deviations, which are related to the change of $\bar{v}^2$ from that given by the Maxwell–Boltzmann distribution and the variation of g(R) with density, are discussed, as well as the feasibility of observing these effects experimentally.

VACUUM PHYSICS

533.5

8720 PUMPING EFFECT OF A GAS DISCHARGE HIGH-VACUUM PUMP. L.Pátý.
Nature (London), Vol. 185, 674-5 (March 5, 1960).

Describes experiments directed towards the elucidation of the pumping process in the Lawrence type of pump (Abstr. 5898 of 1953). The results support the view that pumping is due to the transport of ions and not to sorption processes. A.H.W.Beck

533.5

8721 A VACUUM ADSORPTION PUMP.
B.G.Lazarev and M.F.Fedorova.
Zh. tekh. Fiz., Vol. 29, No. 7, 862-5 (July, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 778-80 (Jan., 1960).

The construction of the pump (based on the adsorption of gases by cold charcoal) is described. The basic characteristics of the pump are examined in its application to the evacuation of nitrogen and air: limiting vacuum ($<10^{-7}$ mm Hg), the dependence of capacity on pressure, and consumption of liquid nitrogen.

533.5

8722 SOME SENSITIVITIES OF ION GAUGES.
W.McGowan and L.Kerwin.
Canad. J. Phys., Vol. 38, No. 4, 567-9 (April, 1960).

Tabulates the sensitivities of two ionization gauges (an 826-A and a Veeco RG-75) for different gases. For each gauge the ratio of the sensitivities for different gases is compared with the ratio of the ionization cross-sections of the gases. J.Dutton

533.5

8723 VACUUM LEAK TESTING WITH LIQUIDS.
C.C.Minter.
Rev. sci. Instrum., Vol. 31, No. 4, 456-7 (April, 1960).

Describes experiments on the sensitivity of a thermal conductivity leak detector to different probing gases and liquids; liquids having a high latent heat of vaporization were found to be most effective, water for example giving 20 times the effect of H_2.
J.Dutton

533.5

8724 HIGH TEMPERATURE HIGH VACUUM RESISTANCE FURNACE. J.Cohen and W.Eaton.
Rev. sci. Instrum., Vol. 31, No. 5, 522-5 (May, 1960).

An experimental high temperature high vacuum furnace with self-supported tungsten resistance heating elements is described. The furnace is assembled from readily obtainable parts, and knife-edge vacuum seals are used throughout. The volume of the hot chamber is approximately 2 in. diam by 8 in. high; the uniform zone is 2 in. long. A temperature of 2000°C can be attained at a pressure of $\sim 10^{-5}$ mm Hg and at a power expenditure of 12 kW.

533.5

8725 LAYERED WALLS FOR ULTRA HIGH VACUUM CONTAINERS. H.L.Eschbach and R.Jaeckel.
Z. Naturforsch, Vol. 15a, No. 3, 268-9 (March, 1960). In German.

Walls for an ultra-high-vacuum vessel made of an enamelled iron are described. These are, unlike glass, impervious to He and H_2 and, unlike metals do not leak at elevated temperatures due to diffusion. A.H.W.Beck

533.5 : 62

8726 PRODUCTION AND DEMONSTRATION OF ATOMICALLY CLEAN METAL SURFACES.
H.D.Hagstrum and C.D'Amico.
J. appl. Phys., Vol. 31, No. 4, 715-23 (April, 1960).

Ion bombardment as a means of cleaning solid surfaces has been tested by applying it to the the metal tungsten. The test, which showed the resulting surface to be clean, is a sensitive one because atomically clean tungsten is very reactive to the common gases. The test is definitive since it is performed on a material for which there is overwhelming evidence that another means, namely heating, does produce an atomically clean surface. The phenomenon used in this work to observe surface conditions during the cleaning procedures is the Auger-type ejection of electrons by slowly moving positive ions. This is again shown to be a sensitive means of detecting surface contamination. Data on the electron release by ions from heavily contaminated metal surfaces are reported.

VIBRATIONS · ACOUSTICS

534

8727 VIBRATIONS : THEIR EFFECTS AND ANALYSIS. E.J.Richards.
Nature (London), Vol. 185, 899-900 (March 26, 1960).

Report of a meeting of the Acoustic Group of the Physical Society held in London, (Jan. 1960). Among the topics discussed were : the vibration isolation of machinery; the influence of vibrations on the hands of machine operators; the physiological effects of low-frequency vibration in jet aircraft; the fatigue of aircraft structures due to jet noise vibrations.

534.1

8728 ON THE EQUIVALENCE OF THE ROUTH–HURWITZ AND OF THE MARKOV STABILITY CRITERIA. V.Yarominek.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1224-7 (Feb. 21, 1960). In Russian.

The author correlates the Routh–Hurwitz and the Markov stability determinants (Δ_s and S_s^* respectively) : $\Delta_s = a_1^s S_s^*$ and obtains the values of the quantities a_1^s. J.K.Skwirzynski

534.13

8729 VIBRATIONS OF A THICK-WALLED CYLINDRICAL SHELL — COMPARISON OF THE EXACT THEORY WITH APPROXIMATE THEORIES. J.E.Greenspon.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 571-8 (May, 1960).

The results for vibrations of an elastic cylinder as predicted by a number of the approximate shell theories are compared with the results of the exact theory. It is found that the membrane theory of shells is accurate for predicting frequencies and displacement ratios of cylinders with appreciable thickness. Furthermore, the theories which include bending effects as well as membrane effects are good at even the shorter wavelengths; and the theories which include rotatory inertia and shear are accurate over most of the wavelength spectrum of the lowest branch of rather thick shells. However, for the very thick shell (with a ratio of inside radius to outside radius less than 0.5), only the exact theory shows the full characteristics of the displacement distribution.

534.2 : 550.3

8730 PLANE COMPRESSIONAL VOIGT WAVES. F.Collins.
Geophysics, Vol. 25, No. 2, 483-504 (April, 1960).

The Voigt wave equation was extensively studied by Ricker, (1943) who developed an asymptotic solution applicable at sufficiently large distances from the shotpoint. Ricker's solution does not agree with his field results (1953) in all respects. For example, Van Melle (1954) has shown that Ricker's wavelets decay too rapidly with distance to be consistent with the experimental data. This particular difference between theory and observation may arise from the form of the wave source implicitly assumed by Ricker, a doublet impulse of displacement. A single impulse of pressure seems a more reasonable first approximation to the shot. For this source a complete solution for plane waves is developed, valid for all distances and times. A method similar to Ricker's is then outlined for obtaining an asymptotic solution suitable for computations at large distances. The wavelets from the pressure impulse do not decay as rapidly as Ricker's doublet displacement solutions. This is a move toward better agreement with experiment. On the other hand, the pressure impulse wavelets have only a single lobe, a definite move away from the observations. There is some reason to believe, however, that the corresponding spherical waves would be more oscillatory than the plane waves. More mathematical work is needed for further tests of the Voigt solid as a theoretical model for earth waves. The next step suggested is the computation of spherical waves from a pressure impulse.

534.2 : 550.3

ACOUSTIC AND ELASTIC WAVES. MODES, RAYS, AND TRAVEL TIMES. See Abstr. 8349

534.2

8731 PROPAGATION OF THE RAYLEIGH SURFACE WAVES ALONG A ROUGH BOUNDARY OF AN ELASTIC BODY. L.M.Brehovskikh.
Akust. Zh., Vol. 5, No. 3, 282-9 (1959). In Russian.

Deals with propagation of Rayleigh waves along a "rough" surface and calculates attenuation due to scattering on the non-uniformities of this surface. These non-uniformities are treated collectively and scattering on a single non-uniformity is not discussed. It was found that, even if the non-uniformities are small compared with the Rayleigh wavelength, attenuation is strong at certain values of the space period of the distribution of non-uniformities. [English translation in: Soviet Physics—Acoustics (New York), Vol. 5, No. 3, 288-95 (Feb., 1960)]. A.Tybulewicz

534.2

8732 QUASI-RAYLEIGH WAVES IN AN ELASTIC LAYER. I.A.Victorov and R.A.Grigoryan.
Akust. Zh., Vol. 5, No. 3, 366-8 (1959). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 5, No. 3, 373-5 (Feb., 1960).

The structure of waves excited by a source of sinusoidal Rayleigh waves at one of the free surfaces of a plane elastic layer is investigated. When the thickness of the layer exceeds twice the Rayleigh wavelength in the material of the medium, the source of Rayleigh waves excites two normal waves, each having a phase and group velocity almost identical with the phase velocity of the Rayleigh wave. Close to the source, the phase difference between the two waves is nearly zero and the total acoustic field is similar to that of the Rayleigh wave; the combined waves are referred to as "quasi-Rayleigh" waves. A set of non-dimensional curves is given for the distribution of displacements with depth in the quasi- and Rayleigh waves and the transformation of the quasi- into the Rayleigh waves is traced. The assumptions made in the theoretical treatments were verified by pulse experiments using duraloy strip. H.J.H.Starks

534.2

8733 ELASTIC WAVES IN ANISOTROPIC MEDIA. V.T.Buchwald.
Proc. Roy. Soc. A, Vol. 253, 563-80 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr. 8522 of 1960). The displacements due to a radiating point source in an infinite anisotropic elastic medium are found in term of Fourier integrals are evaluated asymptotically, yielding explicit expressions for displacements at points from the source. The relative amplitudes of waves from a point source are thus determined, and it is found that although in general the decay of wave amplitudes is proportional to the distance from the source, it is possible that in certain directions the decay is less than this. The method used in this paper is also shown to be an alternative way of deriving known results concerning the geometry of the propagation of disturbances. As an example, the radiation in a transversely isotropic medium from an isolated force varying harmonically with time is discussed.

534.2 : 550.3

8734 ON THE ATTENUATION OF SMALL-AMPLITUDE PLANE STRESS WAVES IN A THERMOELASTIC SOLID. S.Treitel.
J. geophys. Res., Vol. 64, No. 6, 661-5 (June, 1959).

All real materials have a finite thermal conductivity. This means that stress waves propagating through any physically real solid suffer energy losses due to heat conduction. The equations of motion and of temperature for an elastic solid with a finite thermal conductivity are derived with the aid of the irreversible form of the second law of thermodynamics. Their solution for frequencies of physical interest shows that the attenuation coefficient of a stress wave travelling in such a thermoelastic solid is proportional to the second power of the frequency.

534.2 : 531.5

8735 ACOUSTIC RESONANCE IN SOLID PROPELLANT ROCKETS. F.T.McClure, R.W.Hart and J.F.Bird.
J. appl. Phys., Vol. 31, No. 5, 884-96 (May, 1960).

Attention is drawn to the fact that the solid propellant must, in general, be considered as one of the acoustic media in a rocket motor. The viscoelastic properties of the solid along with those of the burned gases determine the characteristic modes of the system corresponding to the particular boundary conditions imposed on these media by the metal components. In addition, these properties of the media contribute strongly to the selection of the regions of stability and instability of the system and therefore to the intermittent and sporadic nature characteristic of resonant burning in solid propellant motors. Calculations are carried out to illustrate the general nature of the phenomenon, and the relationship of these studies to a variety of experimental observations is discussed.

534.21 : 538.56 : 621.372.829

THEORY OF WAVE PROPAGATION IN VARIABLE CROSS-SECTION WAVEGUIDES. See Abstr. 7230

534.21 : 551.5

8736 ON THE GRAVITATIONAL DAMPING OF SOUND. S.B.Pikel'ner.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1827-8 (Dec., 1959). In Russian.

It is pointed out that in the second approximation the flux of sound energy must diminish in the field of gravity independently of whether it travels upwards or downwards. The effect is estimated for an isotermic atmosphere and for an adiabatic motion of the gas in the sound packet. P.Roman

534.22

8737 VELOCITY OF SOUND IN TWO-COMPONENT SYSTEMS. L.Knopoff.
J. geophys. Res., Vol. 64, No. 3, 359-61 (March, 1959).

The velocity of sound has been measured between the liquids and solidus temperatures in two-component systems. For high frequencies, the results show the transitions to be second order transitions. On this basis, the decrease in velocity in the region F of the earth's core, reported by Jeffreys (1939), is shown to be inconsistent with the assumption of a simple iron-nickel composition for both the solid inner and liquid outer cores.

534.22

8738 MEASUREMENT OF THE VELOCITY AND ATTENUATION OF ULTRASONIC SURFACE WAVES IN HARD MATERIALS. K.N.Vinogradov and G.K.Ul'yanov.
Akust. Zh., Vol. 5, No. 3, 290-3 (1959). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 5, No. 3, 296-9 (Feb., 1960).

Brief experimental details using quartz wedge and contactless magnetoacoustic transducers are described. Experimental results in some metals, alloys, fused quartz and glass are given; velocities at 2.5 Mc/s, attenuation at 2.5, 5.0 and 8.0 Mc/s. Surface and volume wave attenuations are of the same order of magnitude; surface wave attenuation depends on the surface finish. H.D.Parbrook

534.22 : 551.35

8739 SOUND SPEED AND ABSORPTION STUDIES OF MARINE SEDIMENTS BY A RESONANCE METHOD. I. G.Shumway.
Geophysics, Vol. 25, No. 2, 451-67 (April, 1960).

Laboratory measurements of compressional sound speed and absorption were made on 111 unconsolidated marine sediment samples, ranging from shallow water sands to deep-sea clays. In addition, determinations were made of porosity, wet density, and grain size distributions. Frequencies between 20 and 37 kc/s were used. Sound speed values at room temperatures range from 1.474 km/s for a red medium clay to 1.785 km/s for a medium sand. More than one-third of the values are lower than the value for sea water alone. Variations in the speed of sound in unconsolidated sediments as found in nature are caused by the following factors, in order of importance : (1) porosity, because of the great difference in compressibility of water and mineral grains; (2) the factor which produces rigidity, which appears to be related to the abundance of coarse grains; (3) pressure; (4) temperature; (5) compressibility of the grain aggregate, determined from compressibilities of individual minerals. Sound absorption measurements ranged from 0.5 dB/m for a medium clay (28.4 kc/s) to about 20 dB/m for silts and fine sands (between 30 and 37 kc/s). An absorption maximum occurs for sediments of intermediate porosity (0.45-0.6) and intermediate grain size (0.031 mm-0.25 mm). The expression $\alpha = MA_g$ where α is the linear absorption coefficient, M is a frequency-dependent factor related to the sediment volume fraction of grains in mutual contact, and A_g is a computable total acoustically effective grain surface area, predicts the absorption values and the absorption maximum. Absorption measurements at more than one frequency between 20 and 37 kc/s were obtained for 65 samples. Assuming that absorption is directly proportional to frequency raised to a power n, the data yield an average value of n equal to 1.79, with a standard deviation of 0.98.

534.22 : 538.3

EFFECT OF GAS PRESSURE AND CONE ANGLE ON THE VELOCITIES OF ELECTRICALLY EXCITED SHOCK WAVES. See Abstr. 7210

534.22

8740 THE PARAMETERS OF A GAS BEYOND A SHOCK WAVE. Yu. P.Lun'kin.
Zh. tekh. Fiz., Vol. 29, No. 2, 180-8 (Feb., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 2, 155-61 (Feb., 1959).

It is shown that, when the effects of the variable specific heat are taken into account, the parameters are determined by the effective γ', and not by $\gamma = C_p/C_v$. For gases with low dissociation energies, there can be intersections of the corresponding frozen and equilibrium shock adiabatics and shock polars.

534.22

8741 CRATERING AND SHOCK WAVE PHENOMENA IN STEEL PLATES AT HIGH IMPACT SPEEDS. E.B.Mayfield and J.W.Rogers.
J. appl. Phys., Vol. 31, No. 3, 472-3 (March, 1960).

The impact of aluminium projectiles on steel plates for impact velocities of 2500 to 3000 m/sec and about 1100 m/sec was studied. Crater volume and penetration were measured. Shock wave velocity from the free surface was determined and the particle velocity calculated. For annealed 4130 steel plates impacted at 2750 m/sec average velocity, the average free surface particle velocity was 0.205 mm/μsec. Existing theory on cratering and penetration gave excellent agreement with the observed values.

534.22

8742 ATTENUATION OF THE SHOCK WAVE PRODUCED IN A SOLID BY A FLYING PLATE. G.R.Fowles.
J. appl. Phys., Vol. 31, No. 4, 655-61 (April, 1960).

The attenuation of the plane shock wave produced in a solid by a flying plate of the same material is treated neglecting dissipative processes and effects of material rigidity. Explicit formulae for the position of the shock front and the shape of the pulse as functions of time are obtained by application of Friedrich's method. A numerical example for an aluminum target and projectile is presented to illustrate some of the features of the calculation, and an experiment is proposed to test the theory. The experiment should also allow a reasonably precise measurement of sound velocity immediately behind the shock front to be obtained. This possibility applies equally well to the case of target and projectile of different materials.

534.22

8743 REFLECTION AND REFRACTION OF SHOCK WAVES AT THE BOUNDARY OF TWO MEDIA. II. REGULAR REFLECTION FOR OBLIQUE INCIDENCE. A.I.Gubanov.
Zh. tekh. Fiz., Vol. 29, No. 5, 615-24 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 549-57 (Nov., 1959).

For Pt I, see Abstr. 9328 (1959). General equations are obtained from which one may find the pressure in the reflected shock wave when an oblique plane wave is incident on a plane boundary separating two arbitrary media. When there is either a small or a large difference in the two media, this equation can be solved approximately for the case of a shock wave of small amplitude.

534.22 : 535.33

8744 TEMPERATURE MEASUREMENTS OF SHOCK WAVES BY THE SPECTRUM-LINE REVERSAL METHOD. J.G.Clouston, A.G.Gaydon and I.I.Glass.
Proc. Roy. Soc. A, Vol. 248, 429-44 (Dec. 9, 1958).

By using a photomultiplier and cathode-ray oscillograph responsive only to changes in light signal, the sodium-line reversal technique, commonly used for measurement of flame temperature has been adapted for time-resolved studies of temperature behind shock waves produced by a bursting diaphragm. The sensitivity of the method is discussed; temperatures can be determined to about ± 30°C. General agreement between calculated and observed temperatures is obtained, but both air and oxygen show a high-temperature region due to burning at the interface with the hydrogen driver gas. In nitrogen at around 2400°K, a low-temperature region close to the shock front may be attributed to a vibrational energy lag of the order of 100 μ sec, the sodium excitation following the effective vibrational temperature rather than the translational temperature of the nitrogen. In oxygen, evidence for a dissociation relaxation effect is obtained for shocks giving temperatures of around 2500°K; this produces an abnormally high temperature near the front. Other irregularities in temperature in the uniform flow is only about half that expected for a real inviscid gas.

534.22

8745 SHOCK-INITIATED DETONATIONS. R.A.Strehlow and A. Cohen.
Phys. of Fluids, Vol. 3, No. 2, 319-20 (March-April, 1960).

Schlieren photographs of reflected shock waves through H_2–O_2–A mixtures are shown. Either detonation or an acceleration of the shock front may occur. The initiation phenomena and the structure of the detonation wave are discussed. A.G.Gaydon

534.22

8746 ACCELERATED FLAMES AND DETONATION IN GASES. H.Jones.
Proc. Roy. Soc A, Vol. 248, 333-49 (Nov. 25, 1958).

The dynamics of accelerated flames in gases, and the transition to detonation are considered. It is shown that in the pre-detonation stage of an accelerated flame there is a fall in pressure and density behind the flame front, and that there the gas velocity is in the opposite direction to the motion of the flame. Increasing compression of the gas in front of the flame leads, after a time, to the development of a shock wave. The properties of this wave are calculated and it is proposed that detonation arises in this shock front which lies in some distance ahead of the flame. The dynamics of the retonation wave, which is a shock wave thrown back into the hot gases at the onset of detonation, is examined and evidence is adduced to show that complete chemical reaction does not always occur in the front of an accelerated flame.

534.23 : 533.6

ACOUSTIC RADIATION FROM A TURBULENT FLUID CONTAINING FOREIGN BODIES. See Abstr. 8684

534.23

8747 COMPENSATING FOR THE REACTIVE LOADING OF HARMONIC RADIATORS. A.Urusovskii.
Akust. Zh., Vol. 5, No. 3, 383-5 (1959). In Russian. English translation in: Soviet Physics—Acoustics (New York), Vol. 5, No. 3, 394-5 (Feb., 1960).

High intensity sound radiation at low frequencies is complicated by the presence of a large reactive loading on the electromechanical transducer many times exceeding the useful resistive load for radiators with much smaller acoustic wavelengths. A method is discussed of compensation for this reactive loading of a piston-type harmonic radiator by using two identical pistons operating with a phase shift of $\pi/2$, one relative to the other, and thus capable of exchanging the reactive energy back and forth by mechanical transmission. The method of achieving this result and the theoretical aspects are discussed. A.B.Wood

534.23 : 621.374.5

8748 ACOUSTIC ELECTRONIC PULSE EQUIPMENT. E.Skudrzyk.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 565-71 (May, 1960).

Detailed information is given for the construction of relatively simple, efficient pulse equipment. The repetition rate of the pulse generator varies between once in 10 sec and 25 000 times a sec with a pulse duration from $\frac{1}{2}$ μsec to 100 msec. Pulses of sinsuoidal oscillations may be generated in the frequency range from 50 c/s to 100 Mc/s. The circuits are free from ringing at frequencies below 5 Mc/s. The power output for pulses of less than 2 msec duration is between 50 and 250 W at frequencies below 10 Mc/s. A thyratron stage produces a triggering pulse to activate a monostable multivibrator. The adjustable-width multivibrator pulse passes through a cathode follower and furnishes the screen voltage for the output tube. If the frequency is below a few Mc/s, the output tube may be used to gate a sinusoidal voltage supplied by a standard signal generator. But for high power or at high frequencies, the output tube is preferably driven as a gated, self-excited oscillator. The receiving amplifier may be connected in parallel with the output of the pulse generator so that the same transducer can be used as both sound projector and microphone. This amplifier limits the large voltage of the driving pulse and is capable of full sensitivity immediately after this pulse has decayed. Some valuable experiences with acoustic transducers are discussed.

534.23

8749 ULTRASONIC BARIUM TITANATE ADHESION AND PASTE TRANSDUCERS. A Lutsch.
Nature (London), Vol. 184, 1458-60 (Nov. 7, 1959).

Details are given of the design and manufacture of a barium titanate paste transducer which adheres to the specimen, so overcoming the difficulty of coupling to specimens having rough or curved surfaces. A wider bandwidth than is usual with conventional apparatus is claimed. G.Mott

534.23

8750 ULTRASONIC ABSORPTION AND VELOCITY IN WATER CONTAINING ALGAE IN SUSPENSION. R.Meister and R.St.Laurent.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 556-9 (May, 1960).

A study is made of the ultrasonic absorption and velocity of longitudinal waves in water containing suspended algae in order to determine the effect of biological suspensions on sound propagation. The ratio α/f^2 is found to be independent of frequency and is linearly dependent on algae concentration. These results indicate that scattering is not a mechanism for absorption and also shows that there is neglibible interaction between particles. It was also found that the excess loss due to algae had the same temperature dependence as the shear viscosity. However the magnitude of the excess absorption calculated from the shear viscosity is insufficient to account for the total loss. Assuming that the structural viscosity of the liquid is increased by either the presence of the suspended material modifying the structural viscosity of the pure liquid, or by a structural viscosity associated directly with the cell, it is found that the increase in structural viscosity is 44 time the increase in shear viscosity for a given increase in concentration.

534.23 : 539.2

EXCITATION AND ATTENUATION OF HYPERSONIC WAVES IN QUARTZ. See Abstr. 7867

534.24

8751 REFLECTION OF SOUND FROM RANDOMLY ROUGH SURFACES. J.M.Proud, Jr, R.T.Beyer and P.Tamarkins.
J. appl. Phys., Vol. 31, No. 3, 543-52 (March, 1960).

A study of the reflection of underwater sound from nonperiodic, pressure release surfaces is reported. The Eckart theory (Abstr. 5348 of 1953) for wave reflection from rough surfaces has been adapted (with some modifications) to the experimental work. A portion of the investigation was directed toward a study of the dependence of the intensity reflected in the specular direction on angle of incidence, radiation wave number and the statistics of the reflecting surface. Secondly, a method is illustrated for determination of the r.m.s. amplitude and the correlation function of the reflecting surface from an analysis of the reflected intensity distribution. The radiation wavelength, in this case, must be much larger than the r.m.s. roughness amplitude.

534.26 : 538.56

8752 THE DIFFRACTION AND REFRACTION OF PULSES. V.M.Papadopoulos.
Proc. Roy. Soc. A, Vol. 252, 520-37 (Oct. 27, 1959).

A method is described for solving problems involving diffraction of a plane pulse by a perfectly conducting or absorbent infinite wedge. The method is extended to give results when a perfectly reflecting or absorbent half-plane lies on the surface between two distinct isotropic non-dissipative media. The results are valid both in acoustic and in electromagnetic theory.

534.26

8753 ON THE USE OF COARSE GRATINGS IN ULTRASONICS. G.M.Sreekantath.
Brit. J. appl. Phys., Vol. 10, No. 4, 191-2 (April, 1959).

It is shown how a coarse optical grating may be used to improve the accuracy of ultrasonic velocity and field intensity measurements based on the Debye–Sears diffraction effect. J.Jarzyński

534.26

8754 SCATTERING OF A PLANE TRANSVERSE WAVE BY A SPHERICAL OBSTACLE IN AN ELASTIC MEDIUM. N.G.Einspruch, E.J.Witterholt and R.Truell.
J. appl. Phys., Vol. 31, No. 5, 806-18 (May, 1960).

An analysis of the scattering of transverse elastic waves by spherical obstacles is presented. The scatterer is taken to be (a) a cavity, (b) a rigid sphere, (c) a fluid-filled cavity, and (d) to consist of an elastic material with properties different from those of the surrounding material. The problems are carried as far as possible analytically without approximations and are reported as matrix equations. The solution of these equations yields the expansion coefficients that describe the waves which are scattered outward from the obstacle and which are excited within the scatterer. A

general expression for the scattering cross-section offered to a transverse wave has been derived. The Rayleigh approximation is then considered in detail for three of the cases.

534.27 : 539.2 : 538.2

ROTATION OF THE PLANE OF POLARIZATION OF ELASTIC WAVES BY MAGNETICALLY POLARIZED METALS.
See Abstr. 8057

534.39

8755 ACOUSTIC STREAMING NEAR A HEATED CYLINDER. R.M.Fand and J.Kaye.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 579-84 (May, 1960).

A photographic study employing smoke as the indicating medium has shown the existence of a new type of streaming near a heated horizontal cylinder in the presence of a horizontal transverse sound field. This phenomenon, called "thermoacoustic streaming," is characterized by the development of two vortices above the cylinder; the fluid pattern resemble vortex shedding behind a cylinder in forced flow normal to its axis. In the presence of sound waves whose half-wavelength is six or more times greater than the diameter of the heated cylinder, the formation of the vortex flow is a function of the sound intensity only; for such wavelengths the vortices begin to appear at 140 dB (re 0.0002 μbar) and become fully developed at 146 dB. This type of streaming is a flow phenomenon which is much stronger than isothermal streaming for the same geometry and sound intensity. It appears that thermoacoustic streaming will have important practical applications, particularly in the field of heat transfer.

534.6

8756 THE SPIRAL-PROBE METHOD OF MEASURING STATIONARY SOUND PRESSURE-FIELDS. G.Hübner.
Acustica, Vol. 7, No. 3, 191-2 (1957). In German.

Desribes a method of exploring sound-fields in which a small probe microphone (with preamplifier) describes a spiral path in parallel planes at various distances from sound sources, e.g. in front of a zone-plate, and in front of a loud-speaker. Lines of equal sound-pressure which are recorded, show the Fresnel zones for the zone plate and the sound pressure field in front of the loud-speaker (dia. 140 cm. frequency 400 c/s, wavelength 85 cm).
A.B.Wood

534.6

8757 HAND-HELD CALIBRATOR FOR PRESSURE-MEASURING SYSTEMS. E.Rule and T.A.Perls.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 535-7 (May, 1960).

The problems involved in laboratory and field calibrations of high-amplitude dynamic-pressure measuring systems are discussed. A novel method is described which ulitizes the vibration sensitivity of the transducer for the generation of high-amplitude dynamic pressures at a frequency suitable for calibration The design, construction, and evaluation are described for a simple hand-held calibrator based on this principle and providing over-all system calibrations at ±12.5 lb/in^2. and ±5 lb/in^2. at 60 c/s.

534.6 : 621.395.616

8758 METHOD FOR MEASUREMENT OF | E'/I' | IN THE RECIPROCITY CALIBRATION OF CONDENSER MICROPHONES. W.Koidan.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 611 (May, 1960).

A simple method is described for accurately measuring the ratio of the driving current through a capacitor-type sound source to the open-circuit voltage of a microphone used as the sound receptor. Determination of this ratio in a reciprocity calibration procedure eliminates the need for measurement of the capacitance of the reversible microphone.

534.62

8759 ABSORBENT LININGS OF GLASS STAPLE FIBRE FOR AN ACOUSTIC TEST CHAMBER.
L.Z.Pronenko and A.N.Rivin.
Akust. Zh., Vol. 5, No. 3, 378-9 (1959). In Russian. English translation in: Soviet Physics–Acoustics (New York), Vol. 5, No. 5, 387-8 (Feb., 1960).

Experimental values of the normal incidence absorption coefficient in the range 35 to 400 c/s are given for wedge type absorbent linings made from glass fibre (density 80 kg/m^3 and specific impedance 12 Rayl/cm).
H.D.Parbrook

534.8

8760 ULTRASONIC ASSEMBLY FOR RECORDING IMAGES OF FLAWS IN SHEET METAL.
V.M.Verevkin, N.A.Evdokimov, K.V.Zharkov and L.G.Merkulov.
Akust. Zh., Vol. 5, No. 3, 364-6 (1959). In Russian. English translation in : Soviet Physics – Acoustics (New York), Vol. 5, No. 3, 372-3 (Feb., 1960).

A brief description is given of an ultrasonic apparatus, developed at the V.I.Ul'yanov Leningrad Electrical Engineering Institute, for the industrial control of rolled sheet metal. Flaw images are obtained by the application of a travelling ultrasonic beam, and the method can be applied to the solution of a number of other problems. Preliminary results obtained with the apparatus are given.
C.F.Barnaby

534.81

8761 THE 'FLEXATONE' AND THE 'SINGING SAW'. K.Gentil.
Acustica, Vol. 7, No. 1, 58-9 (1959). In German.

Gives a brief description of a study of the flexural vibrations of the "Flex-a-tone" and the "Singing Saw". The former orginates in the U.S. and, like the latter, is a means of producing Jazz-music. In the investigations described use is made of Chladni sand-figures to indicate the various modes of flexural vibration of these devices.
A.B.Wood

OPTICS . PHOTOMETRY

535.22

8762 RECENT DETERMINATIONS OF THE VELOCITY OF LIGHT IN VACUUM. R.Dupeyrat.
Cahiers de Phys., Vol. 12, 383-8 (Oct., 1958). In French.

Recent determinations are surveyed briefly. Experiments are in progress at M.I.T. using a very accurately made cavity resonator at 9000 Mc/s, from which it is hoped to obtain a precision of 1 in 10^8.
W.T.Welford

535.24

8763 EFFECTS OF FILTER PASS-BANDWIDTHS ON THE RELATIONS BETWEEN DIFFERENT PHOTOMETRIC SYSTEMS. M.Golay.
Arch. Sci. (Geneva), Vol. 12, No. 3, 349-71 (July-Sept., 1959). In French.

In view of its application in photoelectric photometry of several colours, the effect of a difference in pass-bands of filters when two receivers not having identical characteristics are used, is examined. The differences in bandwidth tolerable for a given accuracy are calculated. It is only possible to establish exact relations between the two systems for finite intervals. A compensating effect between the differences in bandwidth and mean wavelength of the filters is deduced. The monochromatic response obtained with the mean wavelength over a defined interval gives better agreement with the many-coloured response than does the calculation with an effective wavelength. The wavelength separation of the filters required to give the colour index for the calculation of an absolute gradient is determined. The quotients $B^{-1}(\partial B/\partial\lambda)$ and $B^{-1}(\partial^2 B/\partial\lambda^2)$ where $B = B(\lambda,T)$ are tabulated from 3000 to 8000 A and for temperatures between 1000^0 and $100\,000^0$.
D.Walsh

535.24

8764 THE ABSOLUTE MEASUREMENT OF LIGHT INTENSITY BY A DIRECT READING THERMISTOR BOLOMETER. G.Gergely, G.Almássy and J.Ádám.
Acta phys. Hungar., Vol. 7, No. 4, 463-7 (1957).

Describes briefly the construction of a thermistor bolometer and the electronic circuit used with it. The bolometer was calibrated by direct heating. Its use in checking photomultiplier tubes is described, together with the use of filters to reduce the light intensity falling on the photomultiplier. Results are quoted.
E.G.Knowles

GEOMETRICAL AND INSTRUMENTAL OPTICS
SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

535.3

8765 MOLECULAR THEORY OF REFLECTION AND REFRACTION OF LIGHT. I. LIGHT INCIDENT FROM VACUUM ON TO AN ISOTROPIC MEDIUM.
B.A.Sotskii and F.I.Fedorov.
Optika i Spetrosk., Vol. 4, No. 3, 365-72 (1958). In Russian. English summary: PB 141047T-4, obtainable from Office of Technical Services, U.S.A. Dept. of Commerce, Washington,D.C., U.S.A.

A theory is developed which gives Fresnel's equations exactly and also deals with the problem of total internal reflection.
W.T.Welford

535.3 : 538.56

RELATIONS CONCERNING REFRACTING SURFACES, WAVE-FRONTS, AND PHASE ERRORS. See Abstr. 7221

535.3 : 550.3

8766 METHOD FOR OBTAINING THE OPTICAL PROPERTIES OF LARGE BODIES OF WATER.
J.E.Tyler, W.H.Richardson and R.W.Holmes.
J. geophys. Res., Vol. 64, No. 6, 667-73 (June, 1959).

Radiative transfer within a hydrosol such as ocean or lake water can best be described by means of the inherent and apparent optical properties of the hydrosol. Equipment for obtaining the important optical properties of large bodies of water is described and a method for computing six optical properties from measurements of radiance distribution is given. The optical properties of Lake Pend Oreille are computed for one condition of the lake and for one narrow region of the spectrum. The experimental values serve to substantiate certain theoretical relationships between the inherent and the apparent optical properties.

535.31

8767 GEOMETRICAL OPTICS AND WAVE OPTICS. A POINT OF METHODOLOGY. A.Biot.
Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 31–4 (March, 1960).
In French.

The statement often made, that geometrical optics (GO) suggests that there is an infinite concentration of light flux at a focus, is criticized as an unfair interpretation. Starting from Fermat's principle, GO gives a method of determining ray paths as the paths along which energy is transported, possibly as energy packets of finite extension; photometry is developed according to GO in terms of energy flux per unit area of a source and on this basis there is no suggestion of infinite flux density. W.T.Welford.

535.31

8768 NEW RAY TRACING SCHEME. P.W.Ford.
J. Opt. Soc. Amer., Vol. 50, No. 6, 528-33 (June, 1960).

A detailed theoretical treatment is given of a new algebraic ray tracing scheme for tracing rays from an object point through any axially symmetrical optical system, including catadioptric systems, which contain spherical surfaces only. An explanation is given of the coordinate systems used which effect considerable simplifications both in the theory and its application. Also presented is a fully worked example of a skew ray trace through a wide angle system. An electronic computer has been programmed for this ray trace and details of this are given. A predetermined scan interval is given to the machine which then proceeds automatically to trace from an object point rays spaced at this interval over the first polar tangent plane. For pencils of all obliquities, vignetting is carried out by the machine, which produces as one of the results the apparent shape of the entrance pupil.

535.31 : 530.19

8769 THE FOCUSING OF RADIATION BY A RANDOM SURFACE WHEN THE SOURCE IS AT A FINITE DISTANCE. M.S.Longuet-Higgins.
Proc. Cambridge Phil Soc., Vol. 56, Pt 1, 27-40 (Jan., 1960).

The random surface is defined as in a previous paper (Abstr. 13134 of 1959). The distribution of intensity observed at a finite distance from the surface when the source is also at a finite distance and the radiation is incident nearly normally is calculated as a function of a parameter depending on the mean square height variation and mean square curvature of the surface. W.T.Welford

535.31

8770 DESIGN CRITERION FOR CORRECTION OF PARALLAX AT THE BEST FOCUS FOR DEFINITION.
G.W.Hampstead.
J. sci. Instrum., Vol. 37, No. 3, 95-9 (March, 1960).

Parallax is the angular aberration of an optical system. Conventional balance of primary against secondary aberration does not give the best definition with freedom from parallax. A design criterion is established to obtain this desirable condition and tolerances are calculated.

535.31

8771 ON THE TRANSVERSE [CHROMATIC] ABERRATION OF OPTICAL SYSTEMS. II. THE REFRACTING ELEMENT. III. DISCUSSION OF THE GENERAL FORMULA. A.Biot.
Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 23-30 (March, 1960).
In French.

For Pt I, see Abstr. 2194 of 1959. An explicit formula is derived in Pt II for the transverse chromatic aberration of a thin lens. In Pt III the forms applicable to special cases, e.g. pupil at a principal plane, object as infinity, are discussed. W.T.Welford

535.31

8772 THE THICK LENS. III. TRANSVERSE CHROMATIC ABERRATION. A.Biot.
Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 12-22 (March, 1960).
In French.

For Pts I and II, see Abstr. 3608-9 of 1960. Explicit formulae are derived for transverse chromatic aberration (TCA) as a function of thickness, refractive index, power, bending and stop position of a thick lens. Tables are given for determining the position of the stop for zero TCA. W.T.Welford

535.31

8773 AUTOMATIC CORRECTION OF FIRST- AND THIRD-ORDER ABERRATIONS. W.P.Hennessy and G.H.Spencer.
J. Opt. Soc. Amer., Vol. 50, No. 5, 494 (May, 1960).

An improvement of a previously described method (see Abstr. 4969, of 1955). The rates of change of aberrations with all parameters of the system are computed by finite difference formulae. The cycles of correction are alternately devoted to primary and secondary aberrations to obtain rapid convergence. W.T.Welford

535.31

8774 OPTICAL ABERRATION COEFFICIENTS. VI. ON COMPUTATIONS INVOLVING COORDINATES LYING PARTLY IN THE IMAGE SPACE. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 50, No. 6, 534-9 (June, 1960).

For previous Pt see Abstr. 13136 of 1959. All explicit computing schemes hitherto considered in the course of the author's work on higher order aberration coefficients have referred to sets of four coordinates lying entirely in the object space. It is sometimes more convenient to use coordinates consisting of two pairs lying in the object and image spaces, respectively, for instance, when investigating the shape of the wavefront. One particular such set (W coordinates) is here considered. An explicit computing scheme for the primary, secondary, and tertiary aberration coefficients relating to the usual paracanonical coordinates has been given on an earlier occasion. The modifications which arise when W coordinates are introduced in their place are given in detail in the present paper. It is shown how one can obtain the aberration coefficients referring to W coordinates from those referring to paracanonical coordinates.

535.31

8775 OPTICAL ABERRATION COEFFICIENTS. VII. THE PRIMARY, SECONDARY, AND TERTIARY DEFORMATION AND RETARDATION OF THE WAVE FRONT. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 50, No. 6, 539-44 (June, 1960).

In previous work the geometrical behaviour of optical systems has been analysed in terms of the displacement ϵ' of the intersection points with the ideal image plane of arbitrary rays, relative to ideal intersection points, ϵ' being expressed as series in ascending powers of suitably chosen variables. The presence of (geometrical) aberrations is entirely equivalently summed up in the equation of the wave front W' in the image space, i.e. of that surface whose normals

constitute the congruence into which the system has transformed the pencil of rays issuing from any object point. The equation of W', when written in a suitable form, differs from that of a certain spherical surface W_0' only through the presence of a term D, here called the deformation of the wave front. D may be approximated by the terms of a power series up to a certain order, the coefficients of which (deformation coefficients) are obviously closely related to the aberration coefficients which earlier defined ϵ'. The principal object of this paper is to establish the relations between these two sets of coefficients, those of the third, fifth, and seventh orders being dealt with explicitly. In the diffraction theory of aberrations on the other hand, one is interested primarily in the normal displacement between corresponding points on W_0' and W'. A function R which describes this displacement may be called the retardation of the wave front. This function is also considered, and simple relations are established between the deformation coefficients and the retardation coefficients, i.e. the coefficients of the power series for R. In so far as D, or R, may in fact be sufficiently closely approximated by the first three orders, one thus has incidentally a convenient set of 28 (monochromatic) performance numbers governing all pencils of rays simultaneously. The numerical values of the deformation and retardation coefficients of the first three orders are given for a certain triplet.

535.31

8776 THE POSSIBILITY OF RESOLUTION OF TWO LIGHT SOURCES WITH STRONGLY DIFFERING INTENSITIES. A.N.Ryazanov.

Optika i Spektrosk., Vol. 7, No. 3, 417-20 (Sept., 1959). In Russian.

Resolution of two sources with different intensities is improved by using an objective in the form of an aluminized glass plate, on which several pairs of narrow slits are ruled at definite distances between the pairs. A.Tybulewicz

535.32

8777 CONTRIBUTION TO THE EXPERIMENTAL STUDY OF REFRACTIVITIES. H.Fousse and J.Grange.

Cahiers de Phys., Vol. 13, 34-40 (Jan., 1959). In French.

In solids, liquids and moderately compressed gases, the polarization of a given molecule under an electromagnetic field is affected by neighbouring molecules, and to a first approximation for isotropic bodies the Lorenz–Lorentz treatment gives a value $\sigma N(n^2-1)h$ for this effect, where N = number of molecules/unit volume, n = refractive index, h = magnetic field of incident wave, and $\sigma = \frac{1}{3}$. Experiments on 36 hydrocarbons and other simple organic compounds, together with SO_2 and NO lead to values of σ varying from 0.21 to 0.40. The critical index of 21 of these compounds was found to be very close to 1.12 in each case. A bibliography gives references to descriptions of the apparatus used. N.Corcoran

535.8

8778 GALILEO'S TELESCOPE. M.Masoud Anwar.

Pakistan J. Sci., Vol. 11, No. 5, 237-8 (Sept., 1959).

The author criticizes the usual treatment for this type of telescope. He gives a treatment linked to the telephoto lens system. E.G.Knowles

535.8

8779 DEVICE FOR MAINTAINING THE FLAT-FIELD RELATION IN A FINITE-CONJUGATE LENS BENCH. R.L.Lamberts.

J. Opt. Soc. Amer., Vol. 50, No. 6, 526-7 (June, 1960).

A lens bench is described which makes use of an electrical bridge and feedback control system to maintain the test object in a flat field for finite-conjugate operation.

535.8

8780 PRISM SCANNER. F.A.Rosell.

J. Opt. Soc. Amer., Vol. 50, No. 6, 521-6 (June, 1960).

The design parameters of the prism scanner appropriate to systems design are investigated analytically using a thin prism approximation and a more exact thick prism analysis. The results are specialized to the case of the spiral mode but the method is applicable to other modes. Design equations and curves are derived for the spiral scanner using the thin prism approximation. By more exact analysis, it is shown that the thin prism analysis is adequate for preliminary design. The results are checked experimentally and are in excellent agreement.

535.6

8781 A NEW OPTICAL METHOD FOR WIDE ANGLE TRACKING. I. J.N.Whyte.

Instrum. Pract., Vol. 14, No. 1, 36-41 (Jan., 1960).

A mirror–prism optical element (prismor) is described, by means of which optical scanning through wide angles can be carried out. Limitations of existing systems are discussed, and a number of examples are given in which the advantages of the new system are demonstrated.

535.6 : 539.2 : 548.7

IMPROVED EYE PIECE GRATICULE FOR MEASURING X-RAY POWDER DIFFRACTION PATTERNS. See Abstr. 8186

535.8

8782 OPTICAL DIFFUSING SCREENS OF HIGH EFFICIENCY. J.Dyson.

J. Opt. Soc. Amer., Vol. 50, No. 6, 519-20 (June, 1960).

Some applications of diffusers require light to be scattered through only small angles, and light scattered through large angles is wasted. A method is described for making diffusers giving only small-angle scattering by etching finely ground glass plates with hydrofluoric acid. Figures are given relating etching time to peak transmitted intensity, beam width, and grain size.

535.8 : 539.23

8783 ANNEALING SILICON MONOXIDE FILMS ON ALUMINIUM MIRRORS. L.Holland, T.Putner and R.Ball.

Brit. J. appl. Phys., Vol. 11, No. 4, 167-8 (April, 1960).

A study is made of the properties of aluminium mirrors protected by thermally evaporated thin coatings of silicon monoxide. Wear resistance of the films is studied by examining scratch-patterns with emery-loaded rubber. Wear resistance is improved by burnishing with soft cloth. It is established that SiO deposited on cold substrates possesses internal stress leading to formation of brittle layers. The layer is annealed by heating above 200°C and this leads to stable film formation. S.Tolansky

535.8

8784 THE POSSIBILITY OF APPLYING TELEVISION TRANSMISSION TUBES IN THE DETECTION OF FAINT OPTICAL IMAGES. I.L.Valik and L.I.Khromov.

Zh. tekh. Fiz., Vol. 29, No. 7, 881-4 (July, 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 7, 796-9 (Jan., 1960).

Experimental results are presented on the sensitivity of large orthicon and image iconoscope tubes for a wide range of exposure times. Storage mechanisms are discussed.

535.8 : 621.383.27

8785 IMAGE FLUCTUATIONS IN CASCADE INTENSIFIERS. L.Mandel.

Brit. J. appl. Phys., Vol. 10, No. 5, 232-4 (May, 1959).

The root mean square fluctuation of the number of photons emitted from the output screen of a cascade image intensifier is calculated. It is shown that the percentage fluctuation exceeds that of the primary photoelectrons by a small factor depending on the light gain per stage.

535.8 : 538.56

8786 ELECTROMAGNETIC DIFFRACTION IN OPTICAL SYSTEMS. I. AN INTEGRAL REPRESENTATION OF THE IMAGE FIELD. E.Wolf.

Proc. Roy. Soc. A, Vol. 253, 349-57 (Dec. 15, 1959).

An integral representation is obtained for the electromagnetic field in the image space of an optical system. This representation, which is not restricted to systems of low angular aperture, is in the form of an angular spectrum of plane waves, and is closely related to that introduced by Luneberg (1944) as a vector generalization of well-known formulae of Debye (1909) and Picht (1925). It is shown that the representation has a simple physical interpretation in terms of a modified Huygens–Fresnel principle which operates with secondary plane waves rather than with secondary spherical waves.

535.8 : 538.56

8787 ELECTROMAGNETIC DIFFRACTION IN OPTICAL SYSTEMS. II. STRUCTURE OF THE IMAGE FIELD IN AN APLANATIC SYSTEM. B.Richards and E.Wolf.

Proc. Roy. Soc. A, Vol. 253, 358-79 (Dec. 15, 1959).

An investigation is made of the structure of the electromagnetic

field near the focus of an aplanatic system which images a point source. First the case of a linearly polarized incident field is examined and expressions are derived for the electric and magnetic vectors in the image space. Some general consequences of the formulae are then discussed. In particular the symmetry properties of the field with respect to the focal plane are noted and the state of polarization of the image region is investigated. The distribution of the time-averaged electric and magnetic energy densities and of the energy flow (Poynting vector) in the focal plane is studied in detail, and the results are illustrated by diagrams and in a tabulated form based on data obtained by extensive calculations on an electronic computer. The case of an unpolarized field is also investigated. The solution is not restricted to systems of low aperture, and the computational results cover, in fact, selected values of the angular semi-aperture α on the image side, in the whole range $0 \leq \alpha \leq 90^{\circ}$. The limiting case $\alpha \to 0$ is examined in detail and it is shown that the field is then completely characterized by a single, generally complex, scalar function, which turns out to be identical with that of the classical scalar theory of Airy, Lommel and Struve. The results have an immediate bearing on the resolving power of image forming systems; they also help our understanding of the significance of the scalar diffraction theory, which is customarily employed, without a proper justification, in the analysis of images in low-aperture systems.

535.8

8788 A SIMPLE INTERFEROMETRIC ARRANGEMENT FOR THE MEASUREMENT OF OPTICAL FREQUENCY RESPONSE CHARACTERISTICS. P.Hariharan and D.Sen.
Proc. Phys. Soc., Vol. 75, Pt 3, 434-8 (March, 1960).

In the instrument described, collimated light from the lens which is being tested is directed into a triangular path interferometer in which the two beams are sheared by tilting a single, parallel plate, while the path difference between them is varied linearly with time, over a range of one wavelength, by means of a polarizing system. The modulus and argument of the frequency response of the lens are obtained directly from the amplitude and phase of the resultant sinusoidal variation of the total flux in the interference pattern.

535.8

8789 DIGITAL PULSE INTEGRATOR FOR FLASH INTENSITY MEASUREMENTS. H.H.Kramer and E.J.Blair.
J. Opt. Soc. Amer., Vol. 50, No. 6, 607-10 (June, 1960).

A digital pulse integrator is described for measuring the voltage–time area of electrical impulses such as the photocurrent resulting from the photoelectric observation of a xenon flash source. As the basis of its operation, the positive pulse to be integrated charges a capacitor. A decade scaler then counts the number of smaller negative pulses from a crystal oscillator that are required to discharge the capacitor to its original voltage. A specific circuit has been tested both with square pulses having an adjustable amplitude and duration and with linearly attenuated impulses of irregular shape. Repeated measurements of similar pulses are reproducible within ± 1 count. For pulses having amplitudes in the range 50 to 170 V and areas in the range 1.5 to 24 msec V the observed count is linearly proportional to the pulse area within ± 2 counts.

535.8

8790 LIGHT PRODUCTION IN THE ALUMINUM-OXYGEN REACTION. T.H.Rautenberg, Jr and P.D.Johnson.
J. Opt. Soc. Amer., Vol. 50, No. 6, 602-6 (June, 1960).

The mechanisms of excitation of the continuum and the AlO spectra in the aluminium–oxygen combustion reaction were investigated. Aluminium oxide is found to be excited thermally. The colour temperature and intensity of the continuum are limited to the boiling temperature of Al_2O_3. In aluminium–oxygen photoflash lamps, the principal light emission is blackbody radiation from AlO and Al_2O_3 at or below 3800° K. It is concluded that the possibility of substantial alteration of the colour temperature or intensity of the radiation resulting from this reaction is remote.

535.33 : 551.5

8791 RECORDING OF AURORAL SPECTRA USING A PHOTOELECTRIC SPECTROMETER. I.G.Frishman.
Optika i Spektrosk., Vol. 7, No. 4, 574-5 (Oct., 1959). In Russian.

A simple spectrometer, based on a mirror monochromator with a 600 lines/mm diffraction grating, was constructed. In the green region the monochromator had a dispersion of 11.4 A/mm and with 1 mm wide slits it collected radiation from 0.1 square degrees of the sky. A photomultiplier was used as a receiver. Barely visible emission in the 3914-5577 A region was recorded with this spectrometer in 77 sec; this rate could be increased at least five times.
A.Tybulewicz

535.33

8792 A NEW SPECTROPHOTOMETRIC APPARATUS FOR THE EXAMINATION OF MICRO-CRYSTALS.
A.D.Rakcheev.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 4, 758-61 (Feb. 1, 1960). In Russian.

An apparatus using a photomultiplier is described for the rapid determination, in monochromatic polarized light, of the absorption spectrum of a specimen in the form either of a petrographic section or of a powder.
R.F.S.Hearmon

535.33 : 77

8793 THE USE OF A PHOTOMETRIC SPHERE IN DIFFERENTIAL SPECTROPHOTOMETRIC MEASUREMENTS.
Zh.L.Broun.
Optika i Spektrosk., Vol. 7, No. 3, 421-5 (Sept., 1959). In Russian.

Describes the use of Ulbricht's photometric sphere in studies of chemical sensitization of photographic emulsions. The sphere was of 200 mm diameter, covered inside with a layer of magnesium oxide. It was used to obtain the impurity absorption spectrum of a photochemically coloured silver bromide emulsion, with allowance for scattering of light. It was found that the absorption curves obtained with the sphere did not differ greatly from those obtained spectrophotometrically. Scattering resulted in a displacement of the spectrophotometric curves compared with those obtained by means of the photometric sphere. The use of the sphere may be justified in cases where it is necessary to separate out absorption effects particularly when scattering alters considerably during measurements
A.Tybulewicz

535.33

8794 EMISSION SPECTROSCOPY WITH INFRARED DOUBLE-BEAM SPECTROPHOTOMETERS. J.Braunbeck.
Nature (London), Vol. 185, 754 (March 12, 1960).

By attenuating the reference beam of a double-beam spectrometer, the emission spectra of moderately heated gases can be obtained. The spectrum of ammonia at 160° C in the 9-12 μ region is shown as an example.
D.L.Greenaway

535.33

8795 METHODS FOR OBTAINING CORRECTION FACTORS FOR FLUORESCENCE SPECTRA AS DETERMINED WITH THE AMINCO-BOWMAN SPECTROPHOTOFLUOROMETER.
C.E.White, M.Ho and E.Q.Weimer.
Analyt. Chem., Vol. 32, No. 3, 438-40 (March, 1960).

A description is given of five methods of evaluating the relative energy obtained at the exit slit of the excitation monochromator, using a Xe arc as the source. The methods are chemical actinometry, use of a calibrated photomultiplier, use of a thermopile, photography, and measurement of fluorescence. A specimen table of relative intensity factors is given for the range 2400-5900 A, and another for correction of emission spectra measured with a 1P28 photomultiplier as detector.
S.T.Henderson

535.33

8796 THE CORRECTION OF SPECTRAL LINE SHAPES FOR INSTRUMENTAL AND OTHER BROADENING.
C.P.Flynn and E.F.W.Seymour.
Proc. Phys. Soc., Vol. 75, Pt 3, 337-44 (March, 1960).

A simple and rapid procedure is described for the correction of line shapes observed in any branch of spectroscopy, for distortions governed by the equation

$$f(x_0) = \int_{-\infty}^{\infty} g(x)h(x_0 - x)dx,$$

where f(x) is the observed line shape, g(x) the true line shape and h(x) an instrumental or intrinsic broadening function, provided that the moments of h(x) are finite. As an illustration the method is applied to the case of the distortion, inherent in the modulation technique, of magnetic resonance spectra. Formulae for the correction of moments of lines are also given.

535.33

8797 REFLECTANCE-INCREASING COATINGS FOR THE VACUUM ULTRAVIOLET AND THEIR APPLICATIONS.
P.H.Berning, G.Hass and R.P.Madden.
J.Opt. Soc. Amer., Vol. 50, No. 6, 586-97 (June, 1960).

The extreme ultraviolet reflectance of aluminum prepared under optimized conditions is reviewed including a study of the aging parameters. The theory of reflectance-increasing films for the vacuum ultraviolet is discussed. It is shown that single dielectric films, in addition to preventing the growth of an oxide film, can have a surprisingly strong reflectance-increasing effect on aluminum in this spectral region. The use of MgF_2 as a reflectance-increasing coating for the extreme ultraviolet above 1100 A is considered in some detail. It is pointed out that two-layer reflectance-increasing coatings on aluminum have only a very small advantage over single-layer coatings in the extreme ultraviolet. The usefulness of single slightly absorbing films as reflectance-increasing coatings is treated. The problem of increasing reflectance in the spectral region below 800 A is discussed. A new apparatus is described which allows the preparation and measurement of film samples without exposure to air. The effect of the new high-reflectance coatings on the relative merit of vacuum ultraviolet monochromator designs is considered.

535.33 : 545

THE STANDARD ADDITION TECHNIQUE IN FLAME SPECTROMETRY. See Abstr. 8338

535.33 : 534.22

TEMPERATURE MEASUREMENTS OF SHOCK WAVES BY THE SPECTRUM-LINE REVERSAL METHOD. See Abstr. 8744

535.33

8798 HIGH PRESSURE HIGH TEMPERATURE OPTICAL DEVICE. A.S.Balchan and H.G.Drickamer.
Rev. sci. Instrum., Vol. 31. No. 5, 511-13 (May, 1960).

The high pressure optical cell previously described (Abstr. 937 of 1958) has been modified to permit measurements to 400° C and 200 000 atm. The operating details and methods of temperature and pressure calibration are discussed. The absorption edges of sulphur and of olivine are presented as a function of temperature and pressure.

535.33 : 533.7

8799 OPTICALLY CALIBRATED INFRARED HIGH PRESSURE CELL.
D.E.Williamson, I.A.Nichols and B.Schurin.
Rev. sci. Instrum., Vol. 31, No. 5, 528-32 (May, 1960).

A high pressure optical cell of large aperture has been constructed for use in pressure broadening studies of gases in the infrared region of the spectrum. The cell is tight at both vacuum and 1000 lb/in^2 and constructed of stainless steel with 3 × 1 in. calcium fluoride windows. A method of measuring short path length cell spacing to an accuracy of 1% using an optical "butterfly" is described. Data are presented on the pressure-induced distortion of the cell path length for calcium fluoride windows as well as optical glass windows.

535.33 : 534.23 : 533.7

SENSITIVITY THRESHOLD OF AN OPTICO-ACOUSTIC RADIATION RECEIVER. See Abstr. 8714

535.33

8800 HIGH FREQUENCY LIGHT MODULATION.
R.L.Williams.
J. sci. Instrum., Vol. 37, No. 6, 205-8 (June, 1960).

High frequency light modulation has been realized using a magnetically driven rotor suspended by a magnetic field in a vacuum chamber. With a rotor 1 in. in diameter, having 180 reflecting faces, modulation frequencies in the megacycle region are readily obtainable. Design considerations are given for the rotor described, together with details of the driving and suspension circuit employed. A time constant measurement for an indium antimonide sample is given as an illustration of the system.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

535.39

8801 ATTEMPTS TO EXPLAIN THEORETICALLY THE VARIATIONS OF CERTAIN OPTICAL PROPERTIES OF VERY THIN METALLIC LAYERS AS A FUNCTION OF VARIOUS PARAMETERS. J.P.David.
C.R.Acad. Sci. (Paris), Vol. 250, No. 4, 691-3 (Jan.25, 1960). In French.

The reflection and transmission coefficients and phase angles can be calculated if the relative surface area of the substrate covered by the metal and the crystallite distribution function G(f) are known (see Abstr. 6392 of 1960). Values obtained by taking a given form of G(f) have been thus found for Ag films as a function of their mass thickness and λ. The results agree with experiment.
E.A.Mussett

535.39

8802 ON A METHOD OF MEASURING THE OPTICAL CONSTANTS OF METALS.
L.I.Zhuravleva and M.M.Noskov.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 3, 475-6 (1959). In Russian.

An improved polarimetric method is described. Sensitivity is adequate for the study of metallic films down to 10 A thick and of adsorbed layers of gas on metals. A.F.Brown

535.39

8803 RETROGRADE PROPERTY OF LOW REFLECTING MONOLAYERS. H.Osterberg and L.W.Smith.
J. Opt. Soc. Amer., Vol. 50, No. 5, 494-5 (May, 1960).

For a single non-absorbing film of refractive index $\underline{n}$ between media of different indices there are two values of $\underline{n}$ which, with appropriate choice of the thickness of the film, will give the same curve of reflectivity as a function of wavelength. W.T.Welford

535.41

8804 DEPENDENCE OF RESOLVING POWER OF LUMMER GEHRCKE PLATE AND TRANSMISSION ECHELON ON BACKGROUND INTENSITY AND STAGE OF RESOLUTION DESIRED [WHEN NATURAL LINE-WIDTH IS NEGLIGIBLE].
K.C.Chaturvedi.
Optik, Vol. 17, No. 1, 34-7 (Jan., 1960). In German.

535.41 : 531.72

8805 THE "VERNIER EFFECT" OBSERVED WHEN THE THICKNESS OF THICK LAYERS IS MEASURED USING AN INTERFEROMETRIC METHOD.
I.N.Shklyarevskii, E.T.Verkhovtseva and G.N.Polyakova.
Optika i Spektrosk., Vol. 7, No. 4, 566-8 (Oct., 1959). In Russian.

Deals with the effect of phase-shift dispersion on coincidence of equal-chromatic-order lines (the "vernier effect") in measurement of film thickness by Shklyarevskii's method (Abstr. 1040 of 1960).
A.Tybulewicz

535.42

8806 THE ECHELETTE THEORY.
S.G.Rautian.
Optika i Spektrosk., Vol. 7, No. 4, 564-6 (Oct., 1959). In Russian.

Deals with double reflection inside a diffraction-grating groove, which may lead to screening of incident or diffracted waves. Intense negative orders, reported by many spectroscopists, are shown to be due to double reflection inside grating grooves. Double reflection also increases the grating reflection coefficient at large angles of diffraction. A.Tybulewicz

535.42

8807 SCALAR DIFFRACTION IN TERMS OF COHERENCE.
W.H.Steel.
Proc. Roy. Soc. A, Vol. 249, 574-88 (1959).

In scalar diffraction theory, an optical instrument can be treated as a linear system for the two limiting cases of coherent and incoherent illumination of the object, these treatments being in terms of complex amplitude and intensity, respectively. But when the illumination of the object is partially coherent, the system is no longer linear in either of these quantities and a two-stage treatment

involving both quantities has been customary. Wolf has indicated the advantages of formulating diffraction theory in terms of an observable correlation function, here called the "coherence", rather than in quantities such as amplitude which are not observable at optical frequencies. A Fourier theory of diffraction is developed here based on the coherence between radiation at pairs of points. As in general the coherence across a plane is a function of four spatial co-ordinates, the Fourier transforms used are in four dimensions for monochromatic light and in five for light of a finite spectral bandwidth. This diffraction theory is linear for all optical systems with illumination of any degree of coherence and leads to the concept of a "coherence transfer function" to describe the performance of the instrument. In special cases, this reduces to the well-known "contrast transfer function" for incoherent illumination and to the transfer factors used in Hopkins's treatment of partially coherent illumination. The theory also gives the transfer properties and the compensations required for two-beam interferometers and shows how the wave-shearing interferometer serves as an instrument for measuring coherence.

535.42 : 534.21

8808 DIFFRACTION OF LIGHT BY A THREE-DIMENSIONAL SYSTEM OF ULTRASONICS. P.Phariseau.
Physica, Vol. 24, No. 12, 985-95 (Dec., 1958).

A system of linear and homogeneous equations is established for describing the diffraction of light by a three-dimensional system of ultrasonics. A well-known method of first approximation is used to explain diffraction patterns of the first order. To obtain explicit expressions for the intensities Laue and Bragg cases must be distinguished. In some circumstances, total reflection is possible. Neglecting the absorption the conservation of energy was verified. The reflections in the disturbed slab nearly satisfy the Bragg law.

535.43

8809 OPTICAL CONDITIONS INSIDE A MEDIUM WITH RAYLEIGH SCATTERING. G.V.Rozenberg.
Optika i Spektrosk., Vol. 7, No. 3, 407-16 (Sept., 1959). In Russian.

Considers the optical conditions in a medium with Rayleigh scattering; these conditions are a function of the properties of the medium, its absorptivity and depolarization. Various calculation methods are compared and errors due to neglect of the polarization effects are estimated. The possibility of use in spectroscopy of the relationships established here is discussed. A.Tybulewicz

535.51

8810 EXPERIMENTAL STUDY OF THE POLARIZATION OF LIGHT BY ECHELETTE GRATINGS IN THE 1-600 μ REGION. A.Hadni, E.Décamps, D.Grandjean and C.Janot.
C.R.Acad. Sci. (Paris), Vol. 250, No. 11, 2007-9 (March 14, 1960). In French.

Presents interim results of a study of a series of gratings with different line spacings. The polarizer consists of four sheets of polythene at the Brewster angle. Results for two directions of both the electric vector and the echelette rulings show some discrepancies with the scalar theory of Hadni and Décamps. D.L.Greenaway

535.55 : 532.5

8811 THE MEASUREMENT OF FLOW ANISOTROPY IN PURE LIQUIDS. J.V.Champion.
Proc. Phys. Soc., Vol. 75, Pt 3, 421-33 (March, 1960).

In a previous paper (Abstr. 1134 of 1959) a calculation was made of the optical anisotropy due to shearing a simple liquid. A coaxial cylinder apparatus suitable for the measurement of the streaming birefringence of pure liquids at very high velocity gradients (50 000 sec^{-1}) was constructed in order to test this calculation experimentally. A new experimental technique to enable a weak birefringence to be measured was developed, the liquid being sheared for the shortest possible time (~ 10 sec), so that the heating effects within the liquid were negligibly small. Measurements on ethyl cinnamate, chloroform and carbon tetrachloride are described and for the tetrahedral molecule (CCl_4) there is a favourable agreement between experiment and theory. This agreement shows that the assumptions made and the conclusions drawn in the previous paper are reasonable.

COLORIMETRY . PHOTOGRAPHY

77

8812 INFRARED PHOTOGRAPHY. L.Larmore.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1487-8 (Sept., 1959).

A discussion of the response characteristics of infrared photographic emulsions, and a comparison of infrared photography with other methods of detecting infrared radiation. C.Hilsum

77

8813 INVESTIGATIONS ON THE DIFFUSION HALO IN PHOTOGRAPHIC EMULSIONS. G.Haase and H.Müller.
Optik, Vol. 17, No. 1, 1-24 (Jan., 1960). In German.

Theoretical. On the basis of the diffusion equation for light scattering in absorbing media the forms of the point and line spread functions and of an edge image are calculated. There are 50 references. W.T.Welford

77

8814 PRINT-OUT PROCESS IN PHOTOGRAPHIC EMULSION GRAINS. J.F.Hamilton and L.E.Brady.
J. appl. Phys., Vol. 31, No. 3, 609-10 (March, 1960).

The theory that space is made for the growing silver inclusion by the formation of prismatic dislocations at the interface of the inclusion and the crystal is supported by the appearance, on electron micrographs of replicas of exposed grains, of protrusions in groups of three. G.F.Lothian

77

8815 DETERMINATION OF THE ABSOLUTE SENSITIVITY OF SOME PHOTOGRAPHIC MATERIALS TO ULTRA-SOFT X-RADIATION. A.P.Lukirskii and I.A.Karpovich.
Optika i Spektrosk., Vol. 6, No. 5, 685-7 (May, 1959). In Russian.

Reports a determination of the absolute sensitivity of spectrographic plates No. 3, special N.I.K.F.I. films and Schumann plates to X-rays of wavelengths 23.6, 44, 67 and 113 A. The absolute sensitivities of these materials were found to be of the order of 10^7-10^8 quanta/mm^2. A.Tybulewicz

77 : 534.8

8816 ACTION OF SOUND ON THE PROCESS OF DIFFUSION FROM A LIQUID TO A GEL. M.E.Arkhangel'skii.
Akust. Zh., Vol. 5, No. 3, 363-4 (1959). In Russian. English translation in : Soviet Physics – Acoustics (New York), Vol. 5, No. 3, 370-2 (Feb., 1960).

Rate of photographic development, which depends mainly on the rate of diffusion of the developer in the photosensitive film, is accelerated in an ultrasonic field, and the main factors involved are now investigated viz., acoustic wind, cavitation, frequency dependence, and local heating, and temperature variation connected with adiabatic compression and expansion of the medium. It is concluded that variable acoustic pressure is the main factor, which during one half-period promotes penetration of the liquid into the gel pores and changes the pores themselves, and the penetrating liquid, being bound in the gel by absorption or some other kind of force, is not removed during the second half-period. Local increase in the temperature of the sensitive layer is the second-most important factor. H.H.Hodgson

77 : 535.33

THE USE OF A PHOTOMETRIC SPHERE IN DIFFERENTIAL SPECTROPHOTOMETRIC MEASUREMENTS. See Abstr. 8793.

HEAT . RADIATION

536.2 : 621.315.21

8817 THE PROBLEM OF THE ZONE OF ACTION OF AN UNINSULATED TUBE IN A SOLID MASS. L.M.Al'tshuler.
Zh. tekh. Fiz., Vol. 29, No. 2, 224-31 (Feb., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 2, 194-200 (Feb., 1959).

An analysis is made of the various definitions of the zone of action (of the temperature field) of an uninsulated tube in a solid mass. A new definition is introduced for the zone of action and its

radius. A formula is obtained for the radius of the zone and is used to solve some practical problems: a criterion is established for treating two tubes as isolated single tubes. Formulae are deduced for the quantity of heat and the time required for the heating-up of the mass.

536.2 : 621.315.2

8818 THE METHOD OF THE "SUPPLEMENTARY LAYER" IN FORCHHEIMER PROBLEMS. L.M.Al'tshuler.
Zh. tekh. Fiz., Vol. 29, No. 2, 232-8 (Feb., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 2, 201-7 (Feb., 1959).

An estimate is made of the accuracy of the "supplementary layer" method used to improve the precision of the Forchheimer formula for the temperature field of a tube in a solid mass. The estimate is based on a comparison of the exact formula [Zh. tekh. Fiz., Vol. 27, 1495 (1957)] with the Forchheimer formula. A correction to the Forchheimer formula is obtained. The results are used for the approximate solution of nonstationary problems, and also for determining the heating-up time of the mass.

536.2 : 621.365.92

8819 THE STATIONARY RADIAL HEAT FLOW IN A HOLLOW CYLINDER FOR ANY BOUNDARY CONDITIONS. F.Stier.
Arch. Elektrotech. (Berlin), Vol. 44, No. 5, 271-4 (1959). In German.

The problem considered is the heat flow between concentric cylindrical electrodes separated by a dielectric, the heat being generated by dielectric loss. A theoretical solution is obtained, and graphs are given to facilitate numerical evaluation of the maximum temperature and the temperature difference between the cylinders.

R.F.S.Hearmon

536.2 : 532.5

HEAT EXCHANGE IN LAMINAR FLOW THROUGH NON-CIRCULAR TUBES. See Abstr. 8614

536.2

8820 FLOW OF HEAT IN A COMPOSITE SOLID.
T.P.Newcomb.
Brit. J. appl. Phys., Vol 10, No. 5, 204-6 (May, 1959).

A solution is given of the problem of heat conduction in a composite solid consisting of two infinite slabs between parallel boundaries, when the interface is subjected to a thermal flux which decreases linearly with time, whilst at the two outer parallel boundaries there is no flow of heat. No assumptions are made concerning the way the heat is shared between the two bodies. This solution is applied to the problem of braking with uniform deceleration and possesses the advantage over previous solutions in that it can be used even when the brake applications are of long duration (over ten seconds). Typical curves showing the transient temperatures developed during braking are given.

536.2

8821 METHOD FOR DETERMINING THE THERMAL CONDUCTIVITY OF INCANDESCENT SOLIDS.
B.B.Brenden and H.W.Newkirk.
J. appl. Phys., Vol. 31, No. 4, 737-8 (April, 1960).

The paper gives an analysis and brief description of a method utilizing a cylindrical sample heated at one end and whose temperature is measured at three points: (1) the heated end, (2) the middle and (3) the top surface. Results are given for (a) graphite and (b) uranium dioxide. Agreement with published values is obtained for (a) but not for (b), indicating the need for further investigation.

E.G.Knowles

536.2

8822 THERMAL CONDUCTIVITY AND DIFFUSIVITY MEASUREMENTS BY AN UNSTEADY-STATE METHOD WITH APPLICATION TO INSULATING MATERIALS CONTAINING MOISTURE AND ICE. A.P.Hatton.
J. mech. Engng Sci., Vol. 2, No. 1, 45-51 (March, 1960).

The equipment is described with which values of thermal conductivity and specific heat were obtained for a number of insulating materials. Results are also given for the variation of thermal properties with moisture content and ice content. A typical result is quoted and a bibliography given. An appendix by Roberts describes a refinement obtained by improving the temperature measuring technique.

E.G.Knowles

536.2

8823 THERMAL COEFFICIENTS OF CERTAIN UKRAINIAN CLAYS AND THEIR DEPENDENCE ON MOISTURE COMBINED WITH THE SOLID PHASE IN DIFFERENT WAYS. M.F.Kazanskii.
Zh. tekh. Fiz., Vol. 29, No. 2, 247-51 (Feb., 1959). In Russian. English translation in : Soviet Physics – Technical Physics (New York), Vol. 4, No. 2, 215-18 (Feb., 1959).

The thermal coefficients of the Pobiyankovsk and Pyzhevsk bentonites and the Chasov–Yarsk clay were determined at different moisture contents by the method of two temperature-time points. Graphs of the dependence of the thermal coefficients on moisture are given. Two singular points were isolated on the thermal diffusivity - moisture curves; the moisture content at the first point is equal to the moisture content of the maximum hygroscopic state and; the moisture content at the second point is equal to the moisture content corresponding to the quantity of moisture adsorbed by the clay. A theory of the physical nature of the singular points is given.

C.F.Barnaby

536.2

8824 RELAXATION THEORY OF THERMAL CONDUCTION IN LIQUIDS. R.E.Nettleton.
Phys. of Fluids, Vol. 3, No. 2, 216-25 (March-April, 1960).

A linear relaxation equation for the heat flux in a fluid, proposed by Vernotte as a generalization of Fourier's law, is shown for liquids to be consistent with the assumption that thermal energy is carried by elastic waves of very high frequency which may be envisaged as being propagated in a continuum. The elastic constants and the velocity of the waves are obtained from the infinite frequency limits of viscoelastic equations, derived in earlier papers to describe the relaxation of compressional and shearing strains, and from these, the relaxation time and thermal conductivity are calculated for several nonassociated liquids with the aid of a theory of Debye. It is shown that the Vernotte equation may be viewed formally, from the point of view of irreversible thermodynamics, as a force–flux equation linking two irreversible processes, and this interpretation makes it possible to calculate terms in the pressure and internal energy which are nonlinear in the temperature gradient.

536.2

8825 HEAT TRANSFER IN LIQUID METALS.
S.S.Kutateladze, V.M.Borishanskii and I.I.Novikov.
J. nuclear energy, Vol. 9, No. 1-4, 214-29 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 422 (1958).

The paper gives a review of the main work of Soviet and other authors on the subject of heat transfer between solid surfaces and flowing liquid metals. The experiments considered include measurements of heat transfer to liquid metals flowing in long and short tubes, and flat apertures, longitudinally between bundles of rods and plates, and transversely round cylinders, for free convection and during condensation of metallic vapours. The influence of additives on the heat transfer coefficient is also considered. The problems discussed include those connected with the boiling of liquid metals and the influence of wetting on the hydraulic resistance and heat transfer coefficient. Formulae are given for calculating heat transfer.

536.2

8826 HEAT TRANSFER BY FORCED CONVECTION.
D.V.Gogate and H.S.Desai.
Proc. Phys. Soc., Vol. 74, Pt 6, 770-3 (Dec., 1959).

The heat transfer between a copper spherical vessel containing hot water and a stream of air passing over it was studied. The apparatus is briefly described. The sphere was inside a wind tunnel consisting of a rectangular wooden case 165 × 38 × 38 cm and open at both ends. An electric fan directed the stream of air through the tunnel. Cooling curves for the vessel for different values of air velocity were obtained, and the results are exhibited as graphs of Nu against Re. The convective process of heat exchange undergoes a relatively sudden change near $Re = 10^3$.

S.Weintroub

536.2

8827 EXPERIMENTAL OBSERVATIONS OF OVERSTABLE CELLULAR CONVECTION. Y.Nakagawa.
Proc. Roy. Soc. A, Vol. 253, 212-17 (Nov. 24, 1959).

Observations of the overstable cellular convection which occurs in a layer of mercury heated uniformly from below, and subject to Coriolis forces, are described. They confirm Chandrasekhar's theoretical predictions regarding the wave number of the cells and of the characteristic period of the oscillatory motions. A detailed

analysis of the movement of tracers clearly illustrates the periodic reversal of the convective circulation and the hexagonal pattern of the convection cells.

536.2

8828 AN EXPERIMENT ON HEAT TRANSFER BY OVERSTABLE AND ORDINARY CONVECTION. I.R.Goroff.
Proc. Roy. Soc. A, Vol. 254, 537-41 (March 8, 1960).

A layer of mercury heated from below and subject to rotation first becomes unstable via a state of purely oscillatory motions. For a Rayleigh number, generally, much in excess of the value at which overstability sets in, the system becomes unstable also for ordinary stationary convection. Chandrasekhar has suggested that one might be able to detect the onset of this latter mode of instability even though it will be superimposed over the overstable pattern. The present experiments confirm this expectation in a quantitative way.

536.2 : 532.5

NON ISOTHERMAL TURBULENT CONVECTION IN A CHANNEL FORMED BY PARALLEL PLANES. See Abstr. 8620

536.2 : 532.5

APPROXIMATE METHOD FOR INTEGRATING THE EQUATIONS OF A LAMINAR BOUNDARY LAYER IN AN INCOMPRESSIBLE GAS IN THE PRESENCE OF HEAT TRANSFER. See Abstr. 8613

536.22 : 532.5

VARIATION OF TEMPERATURE DUE TO SMALL STEADY DISTURBANCES IN A COMPRESSIBLE FLOW. See Abstr. 8612

536.3

8829 BLACKBODY RADIATION.
T.P.Merritt and F.F.Hall, Jr.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1435-41 (Sept., 1959).

The laws relating the radiation from a black body to its temperature are derived and discussed, and the significance of surface emissivity explained. C.Hilsum

536.3 : 535.24

8830 THEORETICAL CONSIDERATIONS ON THE EXPERIMENTAL DETERMINATION OF SPONTANEOUS PHOTON FLUCTUATIONS. G.A.Spescha and M.J.O.Strutt.
Helv. phys. Acta, Vol. 33, No. 1, 53-68 (1960). In German.

When the temperature of a blackbody source is such that $h\nu \gg kT$, where the symbols have their usual meanings, the fluctuations occur according to the statistics of independent quanta. The conditions to be fulfilled by the detector for such fluctuations to be measureable in the visible and near i.r. are found. W.T.Welford

536.3 : 535.24

8831 EXPERIMENTAL DETERMINATION OF SPONTANEOUS PHOTON FLUCTUATIONS.
G.A.Spescha and M.J.O.Strutt.
Helv. phys. Acta, Vol. 33, No. 1, 69-88 (1960). In German.

A Ge p–n phototransistor was found to comply with the requirements stated in the preceding abstract for a detector suitable for studying photon fluctuations in the near i.r. region. The noise output in the 2 kc/s frequency region showed good agreement with the theoretical predictions for Bose–Einstein statistics of photons. W.T.Welford

536.3

8832 RADIOMETRIC QUANTITIES, SYMBOLS, AND UNITS.
E.E.Bell.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1432-4 (Sept., 1959).

The nomenclature, units, and descriptions of the primary physical quantities considered most important to infrared technology are given, together with the preferred symbols. C.Hilsum

536.3

8833 SIMPLE DOSAGE METER FOR HIGH-INTENSITY THERMAL RADIATION. P.H.Thomas and P.G.Smith.
J. sci. Instrum., Vol. 37, No. 3, 73-6 (March, 1960).

The meter uses the melting of a temperature-sensitive paint as an indicator. Calibration curves are given for two versions, one suitable for 5-18 cal cm^{-2}, the other for 16-60 cal cm^{-2}. An approximate theoretical analysis is also given.

536.3

8834 APPARATUS FOR INVESTIGATING TOTAL HEMISPHERICAL EMISSIVITY. J.H.Cairns.
J. sci. Instrum., Vol 37, No. 3, 84-7 (March, 1960).

An apparatus is described for measuring the total hemispherical emissivity of highly polished metals and alloys over the temperature range 100 to 900° C. The apparatus consists essentially of a highly polished, hollow, cylindrical sample supported within an evacuated enclosure of only slightly larger dimensions. Provision is made for raising the temperature of the sample above that of the enclosure by means of an internal heater contained within the hollow sample. Emissivity values are obtained by observing the rate of loss of heat from the sample after switching off the heater, and substituting this observed value in a specially derived radiation equation. An accuracy of better than ±8% and a reproducibility of ±5% are claimed for the emissivity values. Experimental data for titanium are included as an example. The apparatus is also capable of direct measurement of specific heat over the same temperature range to an accuracy of ±2%.

536.3

8835 RADIOMETER FOR FIELD USE.
J.H.McGuire and H.Wraight.
J. sci. Instrum., Vol. 37, No. 4, 128-30 (April, 1960).

A shielded gold-disk radiometer, specially designed for field use, is described. It measured thermal radiation in the range 0.01 to 1.2 cal $cm^{-2}sec^{-1}$. The calibration is not greatly affected by ambient temperature or by prolonged exposure and the error introduced by winds of up to 25 mile/hr is less than 6%.

536.3

8836 COBALT–MANGANESE OXIDE SEMICONDUCTOR BOLOMETERS. A.L.Burkin and I.T.Sheftel'.
Fiz. tverdogo Tela, Vol. 2, No. 2, 288-96 (Feb., 1960). In Russian.

The basic parameters characterising the performance of thermistor bolometers are defined and classified, and methods are given for their measurement. The construction of three types of bolometer is discussed in detail, and their performance is described. V.V.Zakharov

536.3 : 539.2 : 537.312

EFFECT OF TEMPERATURE ON THE RESPONSE OF A LEAD SULPHIDE CELL. See Abstr. 7965

536.3 : 536.48

8837 A SUPERCONDUCTING BOLOMETER AND SPECTROMETER FOR THE FAR INFRA-RED.
T.J.Dean, G.O.Jones, D.H.Martin, P.A.Mawer and C.H.Perry.
Physica, Vol. 24, Supplement, S151 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A robust bolometer employing a tin element at its superconductive transition is described. The instrument is designed to respond to infrared radiation chopped at 10 c/s and the signal is amplified, by a special transformer operating in liquid helium, prior to electronic amplification and recording. A comparison of its performance with that of a pneumatic detector is described. A spectrometer, designed for the far infrared (beyond 50μ), has been constructed and used in conjunction with the bolometer.

536.3

8838 FUNDAMENTALS OF INFRARED DETECTORS.
R.L.Petritz.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1458-67 (Sept., 1959).

A general account of thermal detectors and semiconductor photoelectric cells, with particular mention of the ultimate detection limits. Operation when the detector is limited by background radiation is considered in detail. C.Hilsum

536.3

8839 THERMAL RADIATION DETECTORS.
R.De Waard and E.M.Wormser.
Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1470 (Sept., 1959).

A short description of thermopiles, bolometers and pneumatic detectors. C.Hilsum

536.3 : 539.2 : 537.312

8840 SINGLE-CRYSTAL INFRARED DETECTORS BASED UPON INTRINSIC ABSORPTION.
F.F.Rieke, L.H.DeVaux and A.J.Tuzzolino.

Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1475-8 (Sept., 1959).

The properties of Te and InSb photoconductive cells, and of InSb photoelectromagnetic and p–n junction cells are described. C.Hilsum

536.3

8841 NOISE IN RADIATION DETECTORS. R.C.Jones.

Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1481-6 (Sept., 1959).

The physical mechanisms for the eight kinds of noise found in radiation detectors are described, and the power spectrum given for each type of noise. C.Hilsum

536.3

8842 RANGE EQUATION FOR PASSIVE-INFRARED DEVICES. L.Larmore.

Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1489-90 (Sept., 1959).

A short paper which shows how to calculate the range at which an infrared detector can detect the radiation emitted by a target. C.Hilsum

536.3

8843 RANGE EQUATION FOR ACTIVE DEVICES. K.V.Knight.

Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1490-2 (Sept., 1959).

A short description of rangefinding using pulsed radiation sources. Equations are given for the maximum distance at which an object can be located. C.Hilsum

536.41

8844 THERMAL EXPANSION OF SOLIDS AT LOW TEMPERATURES. B.F.Figgins, E.Huzan and G.O.Jones.

Physica, Vol. 24, Supplement, S181 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). For earlier work see Abstr. 2117 (1957). Brief note, substantially as follows: Measurements of the expansivity of aluminium, solid krypton and solid argon at low temperatures, using X-ray method, are discussed. The low temperature X-ray (Debye–Scherrer) method has been improved by introducing the possibility of motion of the specimen. A sensitive optical method has also been developed which is capable of giving both absolute and relative measurements of expansivity at low temperatures.

536.42

8845 CONDENSED PHASE DIAGRAM OF THE SYSTEM: ARGON–NITROGEN. H.M.Long and F.S.Di Paolo.

Physica, Vol. 24, Supplement, S168-S169 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Din, Goldman and Monroe have reported a visual determination of the liquidus line of the argon–nitrogen condensed phase diagram and conclude that no thermal halt exists. This conclusion, however, can hardly be correct since this would require a complete series of solid solutions in a system where the pure components have different crystal structures, cubic for solid argon and hexagonal for β-nitrogen. A determination of the condensed phase diagram in this system by thermal analysis has indicated the existence of a thermal halt of the peritectic type. Optical examination of the solids formed from argon–nitrogen mixtures has further demonstrated a change in structure as would be expected from a peritectic system.

536.42

8846 SOLID AND LIQUID SOLUTIONS OF KRYPTON AND XENON. R.Heastie.

Physica, Vol. 24, Supplement, S182 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The vapour pressure of solid and liquid mixtures of krypton and xenon has been measured over a temperature range. The solid–liquid phase equilibrium diagram within the range $x = 0$ to $x = 0.44$ (x = mole fraction of xenon) has been determined previously. The solidus and liquidus curves have minima 2° below the melting point of krypton at 114.1°K and at the composition $x = 0.15$. As solid mixtures of certain compositions were heated, cooling was observed at temperatures close to the melting points. This cooling was in all cases associated with a fall in the recorded vapour pressure. This phenomenon may be explained on the assumption that the phase separation, to be expected in solid mixtures of krypton and xenon, has occurred. The interpretation of the results are discussed with reference to the solid solution data obtained by Freeman and Halsey (1956).

536.42

8847 HYDRODYNAMIC BOUNDARY CONDITIONS FOR EVAPORATION AND CONDENSATION. R.Ya.Kucherov and L.É.Rikenglaz.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 125-6 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 88-9 (Jan., 1960).

The boundary conditions are found for hydrodynamic equations in the presence of evaporation and condensation. For small evaporation rates, the temperature jump and the deviation of the vapour pressure from the equilibrium value are shown to be of the order of the ratio between the speed of the vapour flow and the mean speed of heat transfer. In is shown that the expressions commonly used for the flow of materials and heat in the presence of evaporation and condensation contain an error.

536.42 : 532.5

8848 HYDRODYNAMICS OF A TWO-COMPONENT LAYER AS RELATED TO THE THEORY OF CRISES IN THE PROCESS OF BOILING. S.S.Kutateladze and V.N.Moskvicheva.

Zh. tekh. Fiz., Vol. 29, No. 9, 1135-9 (Sept., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 9, 1037-40 (March, 1960).

Some data are presented on the bubbling of a liquid through another liquid. It is found that the change in the hydrodynamic structure of a two-component layer is determined by the same dimensionless parameters as in the transition from bubbling to pellicular boiling. The presence of complex changes in the structure of a two-component layer is definitely established.

536.46

8849 A THEORETICAL TREATMENT OF COMBUSTION IN A SPHERICAL UNDERWATER GAS BUBBLE. D.A.Senior.

Proc. Roy. Soc. A, Vol. 251, 493-503 (June 23, 1959).

The combustion equations and the equation of motion of the surface of the bubble are formulated an the assumptions that the gases are ignited at their centre and that the flame front travels outward in the form of a sphere. The equations are integrated to yield gas pressure and bubble radius as functions of time. Provided that radial displacements are small, the flame speed can be assumed constant. The formulation is then simple and the equations can be integrated in closed form to give non-dimensional solutions. These show that pressure and radius increase at an increasing rate until combustion is complete. Radial oscillations ensue whose amplitude in proportion to the initial radius decreases with increase in the ratio of combustion time to oscillation period. For large radial displacements, the formulation is less simple as finite expansion of the burnt gases at the expense of the unburnt gases is involved, which enhances the flame speed. The effect has already been considered for combustion in a closed spherical vessel (Flamm and Mache 1917), and an important approximate relation between the fraction of gas burned and the pressure rise has been derived :

$$n = (p - P_g)/(P - P_g),$$

where n is the fraction of gas burned, p is the corresponding pressure and P and P_g are respectively the final and initial pressures. The analysis of Flamm and Mache, which is in any case not entirely satisfactory, cannot be used if the total gas volume varies, as in the present instance. An energy method has, however, been found to give the required relation (and incidently to afford a simpler, more rigorous proof of the closed vessel relation and measure of its accuracy). The equations require numerical integration and some typical results are given in graphical and tabular form. These show two features which are absent when displacements are small : as in closed vessels the combustion time is shorter than that for constant flame speed (typically, by a factor of 3); and, during combustion, pressure fluctuations develop which arise from the interaction of combustion and expansion each of which leads to an acceleration of the other.

536.46

8850 ON THE STABILITY OF A PLANE DEFLAGRATION WAVE. J.Menkes.

Proc. Roy. Soc. A, Vol. 253, 380-9 (Dec. 15, 1959).

The stability of a one-dimensional deflagration wave to small disturbances was investigated. By introducing a suitable approximation to the steady-state temperature distribution and after assuming that the Lewis number of the unperturbed flow is unity,

it is possible to obtain an explicit solution to the disturbance equation. It is demonstrated that within the framework of the present analysis the deflagration wave appears to be stable.

536.46

8851 A PRELIMINARY INVESTIGATION OF FIELD-INDUCED ION MOVEMENT IN FLAME GASES AND ITS APPLICATIONS. K.G.Payne and F.J.Weinberg.
Proc. Roy. Soc. A, Vol. 250, 316-36 (March 24, 1959).

The possibility of utilizing (a) the movement of flame ions caused by an applied electrostatic field and (b) the forces acting on flame gases due to such ion movement, as means of managing and improving some combustion processes, is being investigated. A discussion of the underlying principles leads to an outline of potential applications. An account is given of preliminary experimental work on two specific examples, namely, the effect of electric fields on heat transfer from flame gases to solid bodies and on carbon deposition from diffusion flames. Increases in heat transfer in the former and changes in magnitude, location and form of deposition in the latter are described and discussed.

536.46 : 537.52

IGNITION OF GAS MIXTURES. See Abstr. 7109

536.46

8852 FLAME TEMPERATURE OF A LIQUID-FUEL JET ENGINE. I.
N.N.Sobolev, M.M.Belousov, G.M.Rodin, A.G.Sviridov, N.G.Skorobogatov and F.S.Faizullov.
Zh. tekh. Fiz., Vol. 29, No. 1, 27-36 (Jan., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 1, 24-31 (Jan., 1959).

It is shown that, in the visible region, the emission spectrum of the flame of a liquid-fuel jet engine (LFE) working on mixtures such as "tonka" (50% xylidine, 50% triethylamine) + HNO_3 and kerosene + HNO_3 is continuous, and the energy distribution in the spectrum can be described by Wien's formula. The absorptive power of the flame increases from the red to the violet part of the spectrum, and falls off as the oxidant excess coefficient $\bar{\alpha}$ increases. Flame temperatures were measured both by colour and by brightness methods under different working conditions of the LFE. It is shown that for values of $\bar{\alpha}$ close to the stoichiometric value, the measured temperature agrees with the calculated value obtained on the assumption of steady-state flow. The gas temperature in the combustion chamber was also measured.

536.46

8853 FLAME TEMPERATURE OF A LIQUID-FUEL JET ENGINE. II.
N.N.Sobolev, V.F.Kitaeva, G.M.Rodin, F.S.Faizulov and A.I.Fedorov.
Zh. tekh. Fiz., Vol. 29, No. 1, 37-44 (Jan., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 1, 32-7 (Jan., 1959).

The emission spectrum of the flame was investigated in the visible region of the spectrum when the engine was working on a mixture of kerosene and liquid oxygen. It is shown that the emission spectrum is continuous and the absorptive power is nearly unity. The colour temperature was measured under different working conditions. It is shown that in the case of stoichiometric composition experimental and theoretical values of the temperature are nearly equal.

536.46

8854 PYROMETRIC STUDY OF THE FLAME OF AN OXYGEN-SILICON-ALUMINUM FUEL.
N.N.Sobolev, S.É.Frish, N.M.Kulikova, É.N.Lotkova, G.M.Malyshev, G.M.Rodin and A.M.Shukhtin.
Zh. tekh. Fiz., Vol. 29, No. 4, 506-13 (April, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 4, 451-6 (April 1959).

A study has been made of the glow spectrum of the flame of a silicon-aluminium fuel in the visible, utraviolet, and near-infrared regions. It is found that the radiation has a strong continuous spectrum, against which a number of emission lines are weakly discernible, together with two absorption lines and one molecular band of OH. The absorption power of the flame is close to unity. The energy distribution in the visible region of the spectrum has been studied. It is found that it can be described by the Wien formula. The colour and brightness temperatures have been measured for the flame burning under normal conditions. The effects of the composition of the pulp on the temperature of the flame and its distribution along the length of the chamber have been studied. The experimental value of the temperature is found to be close to the calculated value.

536.49 : 539.2

EVAPORATION FIGURES ON THE SURFACE OF SODIUM CHLORIDE CRYSTALS. See Abstr. 7891

536.5

8855 RADIATION PYROMETRY OF METALS IN THE NEAR INFRARED REGION OF THE SPECTRUM. D.Ya.Svet.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 61-3 (Jan. 1, 1960). In Russian.

Discusses derivation of temperature from the relative brightness temperatures at two wavelengths. The closeness of the true temperature depends on variation of emissivity with wavelength, which is generally small enough to have little effect. A table shows experimental results. R.Berman

536.53

8856 HIGH TEMPERATURE RESISTANCE THERMOMETRY.
Instrum. Pract., Vol. 14, No. 1, 62 (Jan., 1960).

The National Bureau of Standards has investigated the properties and characteristics of platinum resistance thermometers designed for use at temperatures above 630.5°C. A successful thermometer design for this range has been developed, and experiments have been performed to determine the stability of this thermometer when subjected to mechanical shock.

536.55 : 537.56

8857 THE MEASUREMENT OF ELECTRON TEMPERATURE IN HIGH-TEMPERATURE PLASMAS.
R.V.Williams and S.Kaufman.
Proc. Phys. Soc., Vol. 75, Pt 3, 329-36 (March, 1960).

The method is based on the simplifying features of helium-like ions and on the rapid establishment of equilibrium between the processes of populating and de-populating the 2^3P_2 level. The specific intensity of the emission line $2^3S_1 - 2^3P_2$ can then be deduced as a function of the electron temperature. In order to test the basic assumption that the electron velocity distribution is Maxwellian for the very fast electrons which produce the atomic excitation, more than one member of the iso-electronic sequence must be studied. Also, an expression containing the relative emission from two members of the sequence eliminates the electron concentration which can only be estimated at present. The intensities of C V and B IV lines from Sceptre IIIA were measured with a combination of a monochromator and a photomultiplier. A carbon arc was used to calibrate the intensities absolutely, and the spatial intensity distribution was determined by means of the Abel integral equation. For typical discharge conditions, the maximum electron temperature attained was in the range $(2\text{-}3) \times 10^5$ deg K. The electron temperature was unaltered by the introduction of the methane. The results suggest that any existing departure from a Maxwellian distribution of electron velocities did not seriously affect the value of electron temperature derived by this method.

536.58 : 537.52

OBTAINING HIGH TEMPERATURES BY MEANS OF A SPARK DISCHARGE. See Abstr. 7105

536.63 : 539.2 : 537.311

8858 SPECIFIC HEAT OF BISMUTH TELLURIDE AT LOW TEMPERATURES. É.S.Itskevich.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 351-8 (Feb., 1960). In Russian.

Specific heat of p-type Bi_2Te_3 was measured between 1.37° and 65°K. At temperatures below 2.5°K specific heat can be described by $C = \gamma T + 464.5(T/\Theta_D)^3$, where T is the absolute temperature, $\gamma = 17 \times 10^{-3}$ J. deg^{-2}(g-atom)$^{-1}$ and $\Theta_D = 155.5$°K. Between 2.5° and 8°K the power exponent in the temperature dependence of specific heat is greater than three. Specific heat of a laminar Bi_2Te_3 lattice is not consistent with the calculations performed for lattices with a large difference between the elastic moduli of a layer and an inter-layer stratum. Data are presented on measurement of the Hall effect and resistance of Bi_2Te_3 at temperatures between 2° and 300°K. The linear term of the specific heat equation is ascribed to holes. The hole mass is estimated as 1.46 m_0.

THERMODYNAMICS

536.7 : 537.56

ENTHALPY AND SPECIFIC HEAT OF OXYGEN AT 1, 3, 10, 30 ATM BETWEEN 1000 and 30 000° K. See Abstr. 7129

LOW-TEMPERATURE PHYSICS

536.48

8859 LIQUID HELIUM-3. J.G.Daunt.
Science, Vol 131, 579-85 (Feb. 26, 1960).
Review article with 44 references.

536.48

8860 THEORY OF LIQUID He^3. S.K.Trikha.
Progr. theor. Phys., Vol. 18, No. 1, 1-22 (July, 1957).

The success of the London's interpretation (1939) of the behaviour of liquid He^4 has suggested a similar approach to the problem of liquid He^3. Liquid He^3 is pictured as a metal in which the ions and the electrons are replaced by particles of the same kind, viz. He^3 atoms. A fraction of the total number of atoms corresponds to the free electrons in the metal and behaves as an ideal Fermi–Dirac gas in a potential well, while the rest of the atoms constitute a quasi-crystalline lattice. Agreement between theory and experiment concerning the specific heat, entropy, vapour pressure and nuclear spin magnetic susceptibility (and its variation with pressure) is found to be satisfactory.

536.48

8861 THE SURFACE TENSION OF LIQUID He^3. S.K.Trikha and O.P.Rustgi.
Progr. theor. Phys., Vol. 17, No. 2, 303-4 (Feb., 1957).

The experimental results are compared with the theory of Kothari and Auluck (Abstr. 939 of 1947) for an ideal degenerate Fermi–Dirac gas. The theory predicts the right order of magnitude, but the wrong temperature-variation. R.G.Chambers

536.48

8862 PHASE DIAGRAM FOR LIQUID He^3–He^4 SOLUTIONS. K.N.Zinov'eva and V.P.Peshkov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1 (7), 33-7 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 1, 22-5 (Jan., 1960).

It is established that the critical point for phase separation in He^3–He^4 mixtures occurs at T = 0.88° K and x = 64% He^3 molar concentration. At T = 0.67° K and x = 82%, the λ line intersects the phase separation curve. Above this temperature both phases are superfluid, while below, the He^3-rich phase is not superfluid.

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8863 THEORY OF WEAK SOLUTIONS OF He^4 IN LIQUID He^3. V.N.Zharkov and V.P.Silin.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 143-53 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 102-8 (Jan., 1960).

The solution is considered as a Boltzmann gas of impurity excitations (associated with the He^4 atoms) in a Fermi liquid. The spectrum of the impurity excitations and the thermodynamics of the solution are examined. Kinetic equations for Fermi and impurity excitations of the solution are derived. The dependences of the diffusion, thermal diffusion, viscosity and thermal conductivity coefficients on temperature and concentration are determined.

536.48

8864 THE HEAT CONDUCTIVITY AND VISCOSITY OF LIQUID HELIUM II. D.F.Brewer and D.O.Edwards.
Proc. Roy. Soc. A, Vol. 251, 247-64 (May 26, 1959).

Measurements were made in glass capillary tubes of 52 and 108 μ diameter, in the temperature range from 1.15° to 2.15° K. For sufficiently small temperature gradients the thermal resistance is independent of the heat flow and is caused solely by the viscosity of the normal fluid, η_n. This viscosity was calculated from the measured thermal resistance data with the use of the existing entropy values, and the results from the two tubes are in very good agreement except for a small deviation at low temperatures which is attributed to slip. The viscosity at the saturated vapour pressure, when corrected for slip, agrees closely with the results obtained by the rotating cylinder viscometer but does not agree with the oscillating disk experiments. The variation of η_n at low temperatures follows the theory of Landau and Khalatnikov (1949) if Δ/k is taken as 8.9° K, but the measured values of the slip correction are slightly larger than would be expected from the theoretical phonon and roton mean free paths. In the 52 μ tube the measurements were extended up to the solidification pressure so as to give η_n as a function of density. Near the lambda line η_n increases rapidly with density, but at low temperatures the variation is quite small and it is found that the contribution from the rotons is almost independent of density.

536.48

8865 MOTION OF CHARGES IN LIQUID HELIUM II. R.G.Arkhipov and A.I.Shal'nikov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1247-51 (Nov., 1959). In Russian.

A study was made of the behaviour of electric charges produced in liquid helium by a β-source. An attempt was made to observe how the charges are "blown away" by the heat flow. It is suggested that the observed hysteretic phenomena are due to suspended impurity particles in liquid helium.

536.48

8866 FILM TRANSFER IN HeII. J.F.Allen.
Nature (London), Vol. 185, 831-2 (March 19, 1960).

Film transfer experiments were carried out with narrow beakers (1.8 mm i.d., 3.6 mm o.d.) with their rims ground concave conically. The beakers were filled either by plunging them beneath the bath or by film transport alone. In the former case the subsequent emptying rate was 13×10^{-3} cm²/sec, in the latter case $\sim 9 \times 10^{-3}$. The filling rate by film flow was $\sim 6.8 \times 10^{-3}$. Continuous stirring of the liquid, inside the beaker increased the emptying rate by > 10% but decreased the film-filling rate by ~ 10%. It is suggested that the movement of the film is intimately associated with turbulence and that the commonly accepted notion of a 'critical' velocity may have to be abandoned. The film is envizaged to move on "vortex line roller bearings". The more vorticity there is available at the source of the film, the more liquid will be transfered. See following abstract. H.London

536.48

8867 MECHANISM OF SUPERFLUID FLOW. C.G.Kuper.
Nature (London), Vol. 185, 832-3 (March 19, 1960).

It is thought that the discontinuity in velocity commonly assumed to occur near the wall in superfluid flow implies a drastic change in the wave-function over a distance of the order of one inter-atomic distance and hence requires a large energy per unit area. A lower energy would be required if the flow rolls over a row of parallel vortex lines situated close to the wall. On a Rollin film of thickness t there is, owing to the quantization of the lines, a minimum flow rate for this type of flow, which is $\sim 4\pi^2\hbar/mt$, in contrast to the usual maximum (critical) velocity of $\sim \hbar/mt$. In general energy will have to be supplied in order to replace the vortex lines which are carried away by the flow. The present suggestion is that there is a velocity of minimum energy dissipation - the velocity normally observed in steady flow. See preceding abstract. H.London.

536.48

8868 ON THE PROPERTIES OF HELIUM FILMS AND SUPERLEAKS. C.G.Kuper.
Physica, Vol. 24, No. 12, 1009-17 (Dec., 1958).

The properties of liquid helium in very narrow channels and in the Rollin film are investigated theoretically, using as a model Landau's ideal gas with elementary excitations. Besides roton and phonon excitations, surface waves and quantized vortex lines must be considered; moreover the energy of a roton is reduced by the proximity of a solid wall. The order of magnitude of the critical velocity and the dependence of the critical velocity on film thickness can be explained in terms of the surface excitations, but in "superleaks" (e.g. Vycor glass) this mechanism is inoperative. Apart from a contribution to the specific heat at low temperatures, the surface excitations will affect the thermal properties very little.

The reduction of the roton energy near a wall will produce bigger effects in the thermal properties (affecting both films and superleaks). For a saturated film, the effects are still slight, but in a thinner film (or narrow enough channel) the onset temperature for superflow will be reduced considerably; the specific heat will have a broad maximum instead of a λ-anomaly. Both these predictions agree with experiment.

536.48

8869 λ-POINTS IN UNSATURATED HELIUM FILMS. C.E.Hecht.
Physica, Vol. 24, No. 12, 1023-8 (Dec., 1958).

A theoretical study is made of the λ-point in unsaturated helium films and its variations with film thickness. For films of about $\frac{1}{4}$ a liquid layer or less there should be no transition. With increased coverage a transition is possible which is the result of separate λ-transitions for each liquid layer. The temperature of this transition increases rapidly with film thickness to that of bulk helium at a coverage of about 20 liquid layers. Several solid layers may underlie the first liquid layer. Comparisons with and discussions of the diverse experimental data bearing on this problem are included.

536.48

8870 THE ATTENUATION OF SOUND IN SOLUTIONS OF ^{3}He AND ^{4}He.
E.W.Guptill, A.M.R. van Iersel and R.David.
Physica, Vol. 24, No. 12, 1018-22 (Dec., 1958).

Measurements have been made of the attenuation of first sound in mixtures of He^4 and He^3 for different He^3 concentrations (11, 3, 1 and 0.5%) and at temperatures between 0.88°K and the λ-point. In the neighbourhood of 1.0°K the attenuation is diminished greatly by the addition of He^3. Within the accuracy of the experiment the attenuation is proportional to the frequency squared between 7.3 and 12.1 Mc/s.

536.48

8871 HEATING IN LIQUID HELIUM RESULTING FROM NEUTRON AND GAMMA BOMBARDMENT BY A FISSION SOURCE. M.G.Chasanov.
J. appl. Phys., Vol. 31, No. 4, 733-4 (April, 1960).

An upper limit to the rate of boiling is estimated to be $2 \times 10^{-24} \phi_0$ sec^{-1}, where ϕ_0 is the neutron flux from the source.
R.G.Chambers

536.48

8872 RELATION BETWEEN INELASTIC NEUTRON SCATTERING AND THERMODYNAMIC FUNCTIONS OF LIQUID HELIUM. M.Cohen.
Phys. Rev., Vol. 118, No. 1, 27-41 (April 1, 1960).

A model of liquid helium is analysed, in which the liquid is regarded as a collection of excitations ("rotons" only with energy ≥Δ) with an arbitrary pairwise number-conserving interaction. The entropy and normal fluid density of the liquid, and the energy distribution of scattered neutrons are computed as power series in the density of excitations exp(−Δ/kT). The first terms containing effects of the interactions are studied. When the interactions are weak, the entropy [through order exp(−2Δ/kT)] is simply related to the neutron scattering, the connection being correctly given by the formula of Bendt, Cowan and Yarnell (Abstr. 6847 of 1959). For strong interactions there appears to be no simple connection. Even when interactions are weak, the first correction to the normal fluid density involves information which is not contained in the neutron scattering. A method due to Bloch and de Dominicis is used in the analysis, and leads to a new form for the second virial coefficient. This is closely related to a curious new form for the level shift of a particle in a large spherical box, under the influence of a central potential.

536.48

8873 ENTROPY-TEMPERATURE PHASE DIAGRAM FOR He^3. E.F.Hammel, R.H.Sherman, J.E.Kilpatrick and F.J.Edeskuty.
Physica, Vol. 24, Supplement, S1-S8 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). An entropy-temperature phase diagram for He^3 has been constructed from the available published thermodynamic data together with a considerable amount of unpublished P–V–T data from the Los Alamos Scientific Laboratory. In regions where direct information is lacking, reasonable extrapolations from known data have been made.

536.48

8874 VORTEX LINES IN LIQUID HELIUM II. W.F.Vinen.
Physica, Vol. 24, Supplement, S13-S17 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A review of experimental work by Hall and Vinen on (a) mutual friction between vortex lines and thermal excitations, (b) waves on vortex lines, (c) detection of single vortex lines by the Magnus effect.
R.G.Chambers

536.48

8875 EXCITATIONS IN LIQUID HELIUM. R.P.Feynman.
Physica, Vol. 24, Supplement, S18-S26 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A clear summary of the Feynman theory. R.G.Chambers

536.48

8876 THE "1958 He^4 SCALE OF TEMPERATURES". F.G.Brickwedde.
Physica, Vol. 24, Supplement, S128-S129 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A brief description of the stages of development leading to the proposal of the adoption of the "1958 He^4 Scale", which is stated to be superior to both the L55 and 55E Scales and to agree with the thermodynamic scale to within ±2 millidegrees. S.Weintroub

536.48

8877 RECOMMENDATION OF THE 1958-SCALE.
Physica, Vol. 24, Supplement, S129 (Sept., 1958).
In French.

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Statement of the recommendation adopted by the "Comité Consultatif de Thermométrie" of the International Committee of Weights and Measures on June 20, 1958 for the He^4 1958 Scale. Temperatures are to be denoted by T_{58}. S.Weintroub

536.48

8878 VAPOUR PRESSURE TEMPERATURE SCALE FOR THE LIQUID He^4 REGION.
H.van Dijk, M.Durieux, J.R.Clement and J.K.Logan,
Physica, Vol. 24, Supplement, S129-S131 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Details are given of the scale proposed by the authors. It is to cover the range 0.5 to 5.20°K and is defined by a table relating the vapour pressure of liquid He^4 to the thermodynamic Kelvin Scale on which the triple point of water is 273.16°K. The table lists vapour pressures at 0.01 degree intervals. S.Weintroub

536.48

8879 SPECIFIC HEAT OF ^{3}He BELOW 1°K.. D.F.Brewer, A.K.Sreedhar, H.C.Kramers and J.F.Daunt.
Physica, Vol. 24, Supplement, S132 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note substantially as follows. Measurements have been made of the specific heat of pure liquid He^3 between 0.085°K and 0.7°K, under a pressure of about 15 cm Hg. Standard demagnetization techniques were used, the He^3 specimen being cooled below 1°K by thermal contact with iron ammonium alum through a superconducting lead switch. The results agree well with previous measurements which extended down to 0.23°K (Abstr. 5557 of 1954). At lower temperatures, the new data decrease smoothly and may be extrapolated from 0.1°K to 0°K with a slope of 3.75 cal/mole deg^3, in agreement with the theory of Brueckner and Gammel (Abstr. 2278 of 1958). Using this linear extrapolation, entropies at higher temperatures were calculated which were about 0.14 cal/mole deg smaller than those from recent heat of vaporization measurements. (See following abstract). Experiments at higher pressures show that above 0.15°K the specific heat decreases with increasing pressure. Measurements with solid He^3, although complicated by a high thermal boundary resistance, appear to showed an anomaly just above 0.1°K.

536.48

8880 THE HEAT OF VAPORIZATION AND ENTROPY OF LIQUID ^{3}He. D.W.Osborne and B.Weinstock.
Physica, Vol. 24, Supplement, S132 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note substantially as follows. Calorimetric measurements have been made of the heat of vaporization in the range 1.2 to 3.1°K in order to provide accurate values of the entropy of liquid He^3.

Although the heat capacity has been measured down ot 0.1°K, the determination of the entropy by an extrapolation to absolute zero is uncertain. However, the entropy of the liquid can be obtained accurately at a given temperature from the entropy of the gas and the measured heat of vaporization. The heat capacity data can be combined with this value of the entropy to obtain the entropy at other temperatures. The measured heat of vaporization at 1.5°K ($T_{\lambda,SS}$) is 10.39 ± 0.02 cal mole^{-1}. From this it follows that the entropy of liquid He^3 at its saturated vapour pressure at 1.5°K is 2.614 ± 0.03 cal deg^{-1} mole^{-1}. This may be compared with the previously reported value of 2.52 ± 0.17 derived from vapour pressure measurements alone.

536.48

8881 THE THERMAL COEFFICIENT OF EXPANSION OF LIQUID ^{3}He FROM 0.55 TO 1°K. R.D.Taylor and E.C.Kerr.

Physica, Vol. 24, Supplement, S133 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows. Relative density measurements have been performed on liquid He^3 at its saturation pressure from 0.54°K to 1.01°K. The deduced thermal coefficient of expansion $\alpha = 1/V \times dV/dT$, was positive over the entire range; any anomaly in the total coefficient must occur at lower temperatures. Small bore tubing led to a density bulb with a volume of about 3 cm^3 making dead space corrections minor. Seventeen temperature-volume determinations were obtained in the temperature interval with a constant mass of He^3 in the cell. Typical values of α are 0.0036°K^{-1} at 0.55°K, 0.0082 at 0.7°K, and 0.0164 at 0.9°K. The operating characteristics of the cryostat were discussed. Some visual observations in the two phase region, particularly with respect to the fountain effect, were presented.

536.48

8882 SELF DIFFUSION, MUTUAL DIFFUSION AND NUCLEAR SPIN RELAXATION MEASUREMENTS IN ^{3}He. R.L.Garwin and H.E.Reich.

Physica, Vol. 24, Supplement, S133 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows. Spin–echo measurements of diffusion and relaxation in He^3 liquid show a diffusion coefficient which falls only slightly between 3° and 1.8°K and extrapolates from 1.1°K to 0°K at a finite D (about 2×10^{-5} cm^2/s). D varies with molar volume V in the liquid as V^3 over a factor 6 in D, but simultaneous measurements of D and relaxation time T_2 in the coexisting liquid and solid show that the solid has T_2 and D three orders of magnitude less than the liquid at the same P, T, and similar V. D is expected to rise for pure He^3 below the degeneracy temperature, and this question is being investigated to 0.5°K with a He^3 refrigeration system and lower with a continuous demagnetization refrigerator. 2% He^3 in He^4 shows the expected rise in D with decreasing T below T_λ as the excitations are frozen out of the He^4, leaving only the He^4 ground state, analogous to the vacuum of quantum electrodynamics. T_1 for the He^3 does not increase as the square of the dilution, the relaxation remaining a bulk phenomenon, giving perhaps an indication of a clustering of the He^3 atoms in the solution.

536.48

8883 ON THERMAL EXCITATIONS IN LIQUID ^{3}He. L.Goldstein.

Physica, Vol. 24, Supplement, S133 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note substantially as follows. The various experimentally determined thermal properties of liquid He^3 allow an evaluation of its constant volume heat capacity over a fairly wide temperature interval. The heat capacity exhibits at least three inflection points, at 0.35°K, 1.7°K and one at the approach of the critical temperature. The first one is located at the inflection point of the heat capacity of spin disorder beyond its maximum. The third inflection point has a thermodynamic explanation. It originates with the requirement that the finite constant volume heat capacity at the critical temperature be reached with positively infinite first and second temperature derivatives. So far, only the elementary spin orientational excitations emergy clearly as the dominant thermal excitations at the low temperatures. The familiar dissipative processes, if operative at high frequencies, would tend to rule out partial phonon type of excitations in liquid He^3.

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8884 NUCLEAR ALIGNMENT IN SOLID ^{3}He. W.M.Fairbank and E.D.Adams.

Physica, Vol. 24, Supplement, S134 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows. Nuclear resonance techniques have been used to measure the magnetic susceptibility of solid He^3 as a function of pressure and temperature down to 0.12°K. It is found as previously reported by Walters and Fairbank, that below about 0.3°K on many runs the susceptibility falls rapidly below a 1/T Curie law, indicating antiparallel alignment of the nuclear spin similar to the type of alignment observed in the liquid, but beginning at a lower temperature. However, under certain conditions, the behaviour below 0.3°K is strikingly different, even showing a tendency to rise above the Curie curve. Experiments are being carried to higher pressures in an attempt to analyse the properties of these two magnetic states. In particular an investigation is being made of the connection, if any, with the phase transition in solid He^3 observed by Grilly and Mills (1957) below 3.15°K.

536.48

8885 THE VELOCITY OF SECOND SOUND IN LIQUID ^{3}He–^{4}He MIXTURES UNDER PRESSURE. H.A.Fairbank and S.D.Elliott, Jr.

Physica, Vol. 24, Supplement, S134 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements of second sound velocities in superfluid He^3–He^4 mixtures under saturated vapour pressure have recently been completed in concentrations as high as 63.9% He^3 and at temperatures down to 0.2°K. The work is being extended to higher pressures up to the melting pressures for the respective mixtures. As in the case of He^4 the velocity in the mixtures is progressively reduced and the lambda transition temperature falls as pressure is increased. In addition to determinations of the variation of the lambda point with pressure, concentration and temperature, accurate data on the single-phase–two-phase transition, which occurs in these mixtures can be deduced from the second sound measurements. Of particular interest is the effect of pressure on this phase transition.

536.48

8886 THE ABSORPTION OF SOUND IN HELIUM II CONTAINING ^{3}He. G.O.Harding and J.Wilks.

Physica, Vol. 24, Supplement, S134 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The coefficient of absorption as a function of concentration has been investigated and preliminary results of this work are reported.

536.48

8887 THE ATTENUATION OF SOUND IN A DILUTE MIXTURE OF ^{3}He AND ^{4}He BY A METHOD OF FIXED DISTANCE. E.W.Guptill, F.Van Iersel and A.F.Van Itterbeek.

Physica, Vol. 24, Supplement, S135 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The results of experiments on the attenuation of sound in helium II, when small amounts of He^3 are added are given. The attenuation data are obtained by applying 7 Mc/s pulses to one half of a barium titanate cylinder, which is filled with the mixture. The sound pulses are received, after travelling through the liquid, by a very small section of the barium titanate. The exponential decay of successive echoes gives a measure of the attenuation.

536.48

8888 THERMODYNAMIC PROPERTIES OF SUPERFLUID ^{3}He–^{4}He SOLUTIONS. H.London, E.Mendoza and G.R.Clarke.

Physica, Vol. 24, Supplement, S135 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note: Discusses experiments in which a container filled with a He^3–He^4 solution of concentration X mol He^3/cm^3 at temperature T_1 communicates through a super-leak with another container filled with He^4 at temperature T_2.

536.48

8889 LAMBDA AND STRATIFICATION TEMPERATURES OF ^{3}He–^{4}He MIXTURES FROM PRECISION FIRST SOUND MEASUREMENTS. S.G.Sydoriak and T.R.Roberts.

Physica, Vol. 24, Supplement, S135 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Stratification of liquid He^3–He^4 mixtures into two phases at temperature T_s, is clearly demonstrated by first sound velocity, u, in the middle of a vertical cylinder. Sharp breaks in du/dT occur at 478, 616, 717, 795, 846, 836, 695 and 534 millidegrees for He^3 mole fraction, X, of 0.200, 0.301, 0.398,

0.500, 0.597, 0.699, 0.798, and 0.897. Lambda temperatures are clearly apparent in plots of u versus T only for $X \leq 0.398$ whereas sound signal amplitudes have very sharp minima at known T_λ's for $X \leq 0.597$. For $X = 0.699$ and 0.798 no minima were observed, suggesting these mixtures do not have a lambda-type transition. In seeming contradiction, qualitative thermal conductivity measurements on the upper 2% of the liquid show abrupt changes in every mixture studied, at $T = T_\lambda$ for $X \leq 0.597$ and at $T = T_s$ for $X \geq 0.699$. However, the exact composition of this portion of the liquid is uncertain because of possible heat flush effects.

536.48

8890 ON A PARALLEL TREATMENT OF THE COLLECTIVE BEHAVIOUR OF FERMION AND BOSON SYSTEMS.

J.G.Valatin.

Physica, Vol. 24, Supplement, S136 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The simplified version of the Bardeen, Cooper, Schrieffer theory of superconductivity in terms of collective fermion variables has its counterpart in an analogous treatment of liquid helium in terms of sound wave variables. The equations obtained from a variational principle, or from an equivalent linearization of the matter field equations, differ in their mathematical form only through ± signs in the expressions, but their physical content is rather different. For potentials with a predominantly repulsive character the boson equations have collective solutions, whereas the fermion equations do not. The energy spectrum $E_k = \sqrt{\nu_k^2 + \mu_k^2}$ of elementary fermion excitations, where μ_k determines the energy gap, is replaced in the boson case by $E_k = \sqrt{\nu_k^2 - \mu_k^2}$. The correlation function, the sound velocity, the role of Bose condensation and temperature dependence are discussed.

536.48

8891 A VARIATION PRINCIPLE FOR COMPUTATIONS ON THE GROUND STATE OF LIQUID ^{4}He. O.Penrose.

Physica, Vol. 24, Supplement, S136 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief Note, substantially as follows: The simplest acceptable wave functions have the form $\psi = \exp \Sigma_{ij}\varphi(x_i, x_j)$. Assuming two-body forces and taking $\hbar^2/m = 1$, the expectation energy is

$$\tfrac{1}{2}\iint d\tau_{12} f_{12}\{U_{12} - V_1^2\varphi_{12} - (V_1\varphi_{12})^2 - \\ -(V/N)^2 \int d\tau_3 f_{13} f_{23} \nabla_3\varphi_{13}.\nabla_3\varphi_{23}\}, \quad (1)$$

where

$$f_{12} = N(N-1)\int \ldots \int \psi^2 d\tau_{3\ldots N} / \int \ldots \int \psi^2 d\tau_{1\ldots N}, \quad (2)$$

$d\tau_{12} = d^3x_1 d^3x_2$, $\varphi_{12} = \varphi(x_1, x_2)$, etc., and the Kirkwood approximation

$$N(N-1)(N-2)\frac{\int \ldots \int \psi^2 d\tau_{4\ldots N}}{\int \ldots \int \psi^2 d\tau_{1\ldots N}} = (V/N)^3 f_{12} f_{13} f_{23}$$

has been used. This variation principle is to make (1) stationary against independent variations of φ and f. This obviates the intractable integration (2) which would arise in the Rayleigh–Ritz method, since now (2) is equivalent to one Euler equation of the variation problem.

536.48

8892 ON THE THEORY OF SUPERFLUIDITY. V.L.Ginzburg and L.P Pitayevsky.

Physica, Vol. 24, Supplement, S136 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note. For reference to complete text see Abstr. 7869 (1958).

536.48

8893 THEORY OF THE LAMBDA TRANSITION. S.G.Brush.

Physica, Vol. 24, Supplement, S 137 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Feynman proposed a partition function for liquid helium based on his path-integral formulation of quantum mechanics, using an "effective-mass" approximation. Kikuchi introduced a lattice model in order to evaluate this partition function, and obtained a second-order transition. The basic feature of the theory is the representation of the quantum effect by permutation-polygons in the partition function; nearly all of these polygons disappear above the transition temperature because the probability of a polygon of length L is $\propto \exp(-\mathrm{ATL})$. This model can be made more realistic by distinguishing between different kinds of polygons and by allowing vacant lattice sites. It is thereby possible to obtain a negative slope for the λ-line as well as a "classical" liquid-gas transition. The only adjustable parameter is the effective mass for many-sided polygons. This lattice model can also be used to discuss the effect of foreign atoms on the transition.

536.48

8894 SEMICLASSICAL THEORY OF LIQUID HELIUM. E.P.Gross.

Physica, Vol. 24, Supplement, S137 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960) Brief note, substantially as follows: The subject of discussion is the Hamiltonian for a system of bosons interacting by two body forces, as expressed in the formalism of second quantization. Properties of the classical wave field governed by the Hamiltonian are examined. For a general potential there is always an exact solution representing a uniform density. Exact solutions are exhibited, which represent disturbances of a definite velocity and of arbitrary amplitude. For small amplitudes the disturbances obey Bogolyubov's dispersion relation. Corresponding exact solutions are found for disturbances when the system moves as a whole. For suitably attractive potentials a class of exact solutions, degenerate in energy, with spatially periodic density can be found. These solutions have a lower energy than the uniform type. Small amplitude excitations are investigated for the periodic case. They are phonons, for long wave lengths, but show a band character at shorter wavelengths. A theory of the motion of foreign atoms in the boson fluid is formulated.

536.48

8895 HOW CAN THE MULTIPLICITY OF THE GROUND STATE WAVE FUNCTION OF LIQUID HELIUM BE INFERRED FROM THERMOSTATICS. L.Tisza.

Physica, Vol. 24, Supplement, S137-S138 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Discusses the results of Abstr. 6920 of 1958 which conflict with the tacit or explicit assumption of the existing quantum mechanical theories. The rigorous arguments of traditional thermodynamics do not lead to such quantum mechanical statements. The conclusion in question was reached from a new axiomatization of thermodynamics. A characteristic aspect of this approach is that the choice of axioms is flexible and allows to deal rigorously with questions of increasing incisiveness. In addition to the thermostatics of phase equilibrium, the theory is now developed on statistical lines.

536.48

8896 CONSIDERATIONS ON THE HELIUM FILM IN NON-STATIC CONDITIONS. S.Franchetti.

Physica, Vol. 24, Supplement, S138 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The effect of a stationary flow in a helium film has been taken into account by means of appropriate assumptions, and the alteration brought about in the profile of the film has been worked out.

536.48

8897 ON THE PROPERTIES OF THE HELIUM FILM. C.G.Kuper.

Physica, Vol. 24, Supplement, S138 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The properties of the Rollin film are investigated theoretically, using as a model Landau's ideal gas of elementary excitations. Besides roton and phonon excitations, surface waves and vortex lines must be considered. The order of magnitude of the critical velocity and the dependence of critical velocity on film thickness can be explained in terms of these additional excitations. The thermal properties of the film will be affected by the additional elementary excitations. The energy spectrum of rotons is modified by the proximity of a solid wall — this causes a reduction in the λ-temperature (which is slight for a saturated film but may become important is an unsaturated film). A similar effect will occur in superleaks.

536.48

8898 REFRACTIVE INDEX OF ^{4}He. M.H.Edwards.

Physica, Vol. 24, Supplement, S138 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The coefficient of thermal expansion, β, of liquid He^4 has been determined from refractive

index measurements, using (0.12454 ± 0.00021) $cm^3\ mole^{-1}$ as the polarizability for λ = 5462.27 A. The data near the λ-point may be represented to within experimental error by $10^3\beta_I = 41.5 + 14.5 \log |T - T_\lambda|$ for $T > T_\lambda$, from about 0.1° above T_λ to within 0.007° of T_λ; and by $10^3\beta_{II} = -1.5 + 14.5 \log (T - T_\lambda)$ for $T < T_\lambda$, from about 0.1° below T_λ to within 0.002° of T_λ. This implies that the density-temperature curve has both a vertical tangent and a point of inflection at the λ-point; and that the maximum in density occurs about 0.001° above the λ-point. Thirteen absolute measurements of saturated vapour refractive index (and thus of vapour density) have been made between 1.5 and 5.0°K. The data have been used to calculate virial coefficients and thus also the imperfect gas correction to the vapour pressure equation for He^4.

536.48

8899 DETERMINATION OF THERMODYNAMIC PROPERTIES OF HELIUM FROM DIELECTRIC CONSTANT MEASUREMENTS. E.Maxwell and C.E.Chase.
Physica, Vol. 24, Supplement, S139 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Earlier measurements of the dielectric constant of liquid helium under its saturated vapour pressure gave detailed values of the density and thermal expansion coefficient. These measurements have now been extended to pressures of one atmosphere thus permitting the determination of the isothermal compressibility and the slope of the λ-line as well as the thermal expansion coefficient as a function of pressure. Preliminary isothermal compressibility (K_T) data are consistent with the accepted values of the adiabatic compressibility and γ and suggest a discontinuity in K_T of about 3½ at the λ-point. The measurements of $(dp/dT)_\lambda$ and thermal expansion coefficient under pressure, which are also in progress, should permit a direct comparison with the Ehrenfest relation $(dp/dT)_\lambda = \Delta\alpha/\Delta K_T$. Dielectric constant measurements should also prove useful in the determination of vapour densities.

536.48

8900 HEAT FLUSH AND MOBILITY OF IONS IN HELIUM II. G.Careri, F.Scaramuzzi and J.O.Thomson.
Physica, Vol. 24, Supplement, S139 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Further measurements have been performed on the heat flush of positive and negative ions in liquid helium II. The range of measurements has been extended to 0.85°K. From the magnitude of the heat flush effect, the mobilities of the ions can be calculated. At the lower temperatures the positive ion mobilities increase very sharply in accordance with the Landau–Khalatnikov theory of the behaviour of impurities in He II. The behaviour of the negative ions at lower temperatures requires further clarification.

536.48

8901 EXPERIMENTS ON EVAPORATION OF IONS IN LIQUID HELIUM II. G.Careri, U.Fasoli and F.Gaeta.
Physica, Vol. 24, Supplement, S140 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The current due to the movement of positive or negative ions produced by α-rays through the liquid–vapour interface, has been measured as a function of voltage and temperature in liquid nitrogen and liquid helium II. The results in liquid nitrogen indicate an accumulation of charges on the surface layer, which reduces the ionic current one would observe under similar situation in the bulk liquid; this interphase current is rather insensitive to temperature changes and the same behaviour is shown for both the positive and negative ions. In liquid helium instead a sharp dependence on the temperature is observed, and the behaviour is quite different for the positive and negative particles. These results are consistent with and can be explored in the same framework as the ion heat-flush experiments. See preceding abstract.

536.48

8902 MOBILITIES OF He IONS IN LIQUID HELIUM. L.Meyer and F.Reif.
Physica, Vol. 24, Supplement, S140 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The mobilities of positive and negative ions in liquid helium have been measured between 1.2 and 4.2°K and fields of 50–200 V/cm. The mobilities are field independent and increase very rapidly below the λ-point. Below 2°K the temperature dependence of the positive ion mobility is similar to the reciprocal of the density of the normal fluid; in the range above 2°K, the positive ion mobility is approximately inversely proportional to the viscosity of the liquid. The mobility of the negative ions is less than that of the positive ions and the ratio of the mobilities depends somewhat on temperature. These results differ from those of Williams (Abstr. 3202 of 1957) and Careri et al (1957) who found the mobilities strongly field dependent. This discrepancy is probably due to the fact that for very low field strength the ions always remain practically at thermal energies.

536.48

8903 THE VISCOSITY OF LIQUID HELIUM BETWEEN 1.1°K AND 0.79°K. A.D.B.Woods and A.C.Hollis Hallett.
Physica, Vol. 24, Supplement, S140 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A rotating cylinder viscometer has been used in a booster cryostat to measure the viscosity of liquid helium II between 1.1°K and 0.78°K. The results show that the viscosity rises rapidly with decreasing temperature in this range in qualitative agreement with the Landau and Khalatnikov theory. Quantitatively the viscosity at 0.74°K was measured to be 175 ± 10 μ poise and this compares favourably with the theoretical value of 173 μ and 0.8°K.

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8904 VISCOSITY OF LIQUID HELIUM II NEAR THE LAMBDA POINT. J.G.Dash.
Physica, Vol. 24, Supplement, S140-S141 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The theory of Landau and Khalatnikov for the viscosity of liquid He II is examined in the neighbourhood of the lambda point. Arguments are advanced against the validity of the ideal gas approximation for rotons, and a qualitative roton liquid model is proposed. The temperature dependence of viscosity of the liquid model is found to correspond with the observed viscosity above 1.8°K, and with the discontinuity in the temperature derivative of viscosity at the lambda point.

536.48

8905 THE APPARENT MASS OF AN OBJECT MOVING THROUGH LIQUID HELIUM II. J.M.Reynolds, B.J.Good and W.J.Schultis.
Physica, Vol. 24, Supplement, S141 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The hydrodynamic apparent mass of objects undergoing accelerated motion in liquid helium II has been studied by observing its effect on the periods of suitably designed torsion oscillators. Preliminary measurements have been refined and extended to a variety of oscillators with periods ranging from 3 seconds to 40 seconds. Below 1.5°K all oscillators show the apparent additional mass expected for a classical irrotational fluid. At higher temperatures the apparent masses of the long period oscillators rise considerably above this value. As the maximum angular velocity of the oscillator is increased the apparent mass approaches the computed value over the entire range of temperature. The damping of each of these oscillators was observed and is discussed.

536.48

8906 ACOUSTIC STREAMING IN LIQUID HELIUM. B.Daniels-Hunt, K.L.Chopra and J.B.Brown.
Physica, Vol. 24, Supplement, S141 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A suspension of fine particles of a suitable mixture of solid H_2 plus D_2 in liquid helium was used as an indicator in acoustic streaming experiments designed to measure the ratio of the sound absorption coefficient to the shear coefficient of viscosity and hence the ratio of the second (dilatational) to the first (shear) coefficient of viscosity. These coefficients occur in the expression for absorption coefficient of sound and are calculated by Khalatnikov for He II. The streaming appeared, however, to be turbulent to the lowest ultrasonic intensity at which observations were possible. The streaming was found to be independent of temperature and showed no anomaly at or above the lambda point, possibly due to complete absorption of the sound in the turbulent medium.

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8907 WAVES ON QUANTIZED VORTEX LINES. H.E.Hall.
Physica, Vol. 24, Supplement, S141 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A harmonic resonance has been

observed, and the theoretically predicted dependence of wave number on the square root of the frequency has been verified experimentally. The best experimental value of the parameter ν (the ratio of the energy of unit length of line to the product of superfluid density and circulation) is $8.5 \pm 1.5 \times 10^{-4}$ cm^2 sec^{-1}; this corresponds to an effective radius of the order of magnitude of 30 A for the core of the vortex, on Feynman's model. Experiments have been carried out with a modified technique designed to give a more accurate value of ν and to investigate the effect of mutual friction on the wave motion.

536.48

8908 THE MECHANO-CALORIC EFFECT OF LIQUID HELIUM BELOW 1°K. G.J.C.Bots.

Physica, Vol. 24, Supplement, S142 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements have been made of the mechano-caloric effect of liquid helium down to about 0.4°K. The calorimeter, consisting of a cylindrical vessel of glass, partly filled with 20 g of a paramagnetic salt and about 9 cm^3 of liquid helium, was connected via a superleak (a German silver tube filled with fine powder) to a metal bellows. Changing the volume of the bellows, which was totally filled with liquid, superfluid helium could be made to flow into or out of the calorimeter causing a cooling or heating respectively. Changes in temperature were of the order of a few hundredths of a degree for a flow of about 1 cm^3. The results are compared with values derived from London's formula, making use of the specific heat measurements of Kramers et al. (Abstr. 7227 of 1952) and Wiebes et al. (Abstr. 8562 of 1957). The agreement was good. At temperatures below 0.8°K an extra heat capacity was found in the calorimeter as was mentioned by Wiebes. Measurements above 1°K were also in good agreement with the theory.

536.48

8909 THE FOUNTAIN EFFECT IN LIQUID HELIUM II AT PRESSURES FROM 0-30 ATM.

C.J.N.Van den Maydenberg and R.De Bruyn Ouboter.

Physica, Vol. 24, Supplement, S142 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: In an apparatus consisting of two vessels, separated by a superleak, a fountain pressure difference is created by heating one of the two vessels. Whereas the external pressure proves to be nearly constant, the fountain pressure difference can be measured as a function of the temperature difference on an oil manometer. Assuming that London's formula, $\Delta P = \rho S \Delta T$, is valid for Helium II at high pressures, it is possible to evaluate the entropy as a function of temperature and pressure. On extrapolating the entropy values to saturated vapour pressure, good agreement is found with the entropy data of Kramers et al. (Abstr. 7227 of 1952). The deviations are smaller than 2% at temperatures above 1.2°K. At high pressures, however, there is a discrepancy up to about 5% between the calculated entropy values of Keesom and Keesom and the present results. On the basis of these entropy values, combined with the data of first and second sound, calculations are made on the pressure dependence of the roton parameters. For instance, at 25 atm: $\Delta/k = 7.0$°K; $p_0 = 2.15 \times 10^{-19}$ g cm sec^{-1}; $\mu = 0.80 \times 10^{-24}$ g.

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8910 HEAT TRANSFER BY LIQUID ^{4}He II THROUGH NARROW SLITS. W.E.Keller and E.F.Hammel.

Physica, Vol. 24, Supplement, S142-S143 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Simultaneous measurements have been made of the fountain pressure, P_f, and the heat transport by liquid He^4 through a narrow slit at eleven temperatures between 1.1°K and 2.1°K for values of ΔT up to 1000 millidegrees. The slit (1.9 cm long and 2 microns wide) connects two reservoirs of liquid helium, one thermally isolated and fitted with a heater, the other intimately coupled to the helium bath. Two $\frac{1}{2}$ W carbon resistors serve as thermometers. All measurements are made with the isolated reservoir completely filled. Upon heating, the fountain pressure compresses the liquid in this reservoir causing a drop of the liquid level in the colder (reference temperature) reservoir. Observations of this level change together with information on the liquid density and compressibility allow a calculation of P_f. The results show two important divergences from previous similar experiments: (1) initial slopes of heat current v. ΔT are not linear, but concave upward; and (2) plots of heat current v. P_f are also concave upward in disagreement with the Allen–Reekie rule. These results are discussed in relation to present theories.

536.48

8911 A LENGTH EFFECT IN THE HEAT TRANSPORT IN HELIUM II. H.Forstat.

Physica, Vol. 24, Supplement, S143 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The heat transport in helium II has been measured in the temperature range 1.70-2.17°K using an apparatus similar to that used by Forstat and Reynolds. The channels were formed by a column of packed jeweller's rouge and were approximately 0.1 micron in size. A temperature difference was measured across the length of the rouge column after some heat was introduced to the system. In this way a thermal conductivity was calculated. Measurements were made for three independent lengths, 3.179, 5.166 and 8.156 cm. The results verified the linear dependence of the heat current density on temperature difference for small channels and showed a decrease in the thermal conductivity by approximately a factor of 2 as the rough length was increased from 3.179 to 8.156 cm.

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8912 CRITICAL VELOCITIES OF ^{4}He IN A SUPERFLUID FLOW THROUGH A GLASS CAPILLARY OF 260 260 MICRONS DIAMETER. F.A.Staas and R.De Bruyn Ouboter.

Physica, Vol. 24, Supplement, S143 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Critical velocities have been measured with an apparatus consisting of a 1 m thermally insulated glass capillary. The lower end of the capillary was connected to a thermostated ($\pm 10^{-3}$ deg) helium bath and the upper end, through a porous jewellers rouge plug, to a small vessel in good thermal contact with the bath. Superfluid flow was effected by lowering the bath level. The critical velocity is reached as soon as the liquid level in the vessel lags behind the bath level. The results show a pronounced maximum at 1.5°K of 0.5 cm/sec and a gradual fall towards the λ-point in contrast with smaller diameter experiments.

536.48

8913 THE THICKNESS OF THE MOVING HELIUM II FILM. L.C.Jackson and L.G.Grimes.

Physica, Vol. 24, Supplement, S144 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Kontorovich has published a theory which shows that the helium II film creeping out of a vessel should be thinner by a few per cent than the stationary film under the same conditions. The early observations of Jackson and Henshaw were not sufficiently precise to detect such a change. They have now been repeated with improved technique and the expected decrease in thickness has been observed.

536.48

8914 THE NATURE OF THE λ-TRANSITION. M.J.Buckingham.

Physica, Vol. 24, Supplement, S144 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960): Brief note, substantially as follows: Recent experimental results enable a reliable estimate to be made of the precise mathematical nature of the singular behaviour of the thermodynamic functions of liquid helium at the λ-transition. In particular, the specific heat at constant pressure as a function of temperature appears to have a logarithmic infinity at the λ-point. Existing data for other phenomena — magnetic, order–disorder, rotational, etc., transitions — although necessarily available only with much lower temperature resolution, suggest on inspection that this logarithmic behaviour is typical of a large class of thermodynamic transitions, which belong outside the Ehrenfest classification. It is interesting to note that this is also the behaviour of the transition of the two dimensional Ising model, the only example of an interacting system of this type for which the statistical mechanics is known exactly. Approximate methods of solution always give incorrectly the actual singular behaviour.

536.48

8915 UNITED STATES PLANNING FOR THE LARGE SCALE LIQUEFACTION AND TRANSPORTATION OF HELIUM. D.B.Mann and B.W.Birmingham.

Physica, Vol. 24, Supplement, S144 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960).

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8916 SOME TECHNICAL AND ECONOMIC ASPECTS OF THE DISTRIBUTION OF LIQUID HELIUM. P.L.Smith.
Physica, Vol. 24, Supplement, S144-S145 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960).

536.48

8917 HEAT TRANSFER BETWEEN SOLIDS AND LIQUID HELIUM II. L.J.Challis and J.Wilks.
Physica, Vol. 24, Supplement, S145 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: It has been suggested by Khalatnikov (Abstr. 806 of 1953) that the thermal boundary resistance (Kapitza jump) between a solid and liquid helium II is primarily due to acoustic mismatch at the interface. The theory leads to values of the resistance which are larger and much more dependent on the density of the helium than those observed. Khalatnikov assumed the acoustic impedance (ρc) of the helium at the interface to be that of the bulk liquid, thus ignoring the increase in density (and so impedance) near the solid boundary. Using transmission line theory the impedances at the interface and so the values of the boundary resistance have been calculated. These values are closer to those observed and above 1°K are practically independent of pressure, in agreement with experiment. The variation of the resistance with temperature is greater than that calculated, so that some other factor must also be involved, perhaps the microstructure of the solid surface.

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8918 A STUDY OF THE EXCITATIONS IN LIQUID HELIUM BY USE OF SLOW NEUTRONS.
K.E.Larsson and K.Otnes.
Physica, Vol. 24, Supplement, S145 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Using a beryllium filtered beam of thermal neutrons from the Swedish heavy water reactor, R1, it has been possible to excite single excitations in liquid helium. These excitations have been studied by measuring the energy change of the slow neutrons scattered inelastically from a liquid helium sample. It is proved that excitations exist in liquid helium II, which have mean free paths long compared to their wavelength. The dispersion curve of these excitations in the roton region, corresponding to momentum values with $1.50 \leq p/\hbar \leq 2.14$ A^{-1}, has been found to have a parabolic shape, $E = \Delta + (p - p_0)^2/2\mu$, in agreement with Landau's theory. The experimentally determined parameters are $\Delta/k_B = (8.1 \pm 0.4)^\circ$K, $p_0/\hbar = (1.90 \pm 0.04)$ A^{-1} and $\mu = (0.15 \pm 0.02)m_{He}$. These observations were made at a helium temperature of 1.44°K. By increasing the helium temperature from 1.44 to 2.17°K it is found that Δ seems to vary with temperature according to the formula $\Delta/k_B = 8.1\,(1 - 0.585\,(T/T_\lambda)^{13.3})$. By analysing the shape of the scattered spectra, the line width δE comes out as $\delta E/k_B = 14.7 \times (\Delta^{5/2}/T^{4/3})\,e^{-(\Delta/kT)}$. This width is about 2.5 times that predicted by the Landau–Khalatnikov theory.

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8919 MEASUREMENTS OF THE TEMPERATURE DEPENDENCE OF THE EXCITATION SPECTRUM OF LIQUID HELIUM. J.Yarnell, Bendt, E.C.Kerr and Arnold.
Physica, Vol. 24, Supplement, S146 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The authors have completed measurements of the temperature dependence of the excitation spectrum of liquid He, following which Bendt and Cowan have used the experimentally determined energy momentum curve to calculate the thermal properties of helium from 0.3 to 2.1°K. Their results are in excellent agreement with experiment.

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8920 HELIUM II FILM FLOW.
J.F.Allen.
Physica, Vol. 24, Supplement, S146 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The "double-beaker" experiment, made by Daunt and Mendelssohn in 1946, which showed that film flow took place when no level difference was observable between the beakers, has been repeated in such a way that the two meniscuses were no longer in line of sight with each other, but disposed side by side. Under these conditions it was observed that the "outer" level always moved off first followed by the "inner" level. The two levels then oscillated about each other with no mean difference between them greater than 0.01 mm until the bath level was reached.

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8921 OBSERVATION OF BOUNDARIES BETWEEN PHASES OF LIQUID HELIUM. V.P.Peshkov.
Physica, Vol. 24, Supplement, S146 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Zinovieva and the author visually observed the disappearance of boiling and the formation of a stratification boundary in a He^3–He^4 mixture with decreasing temperature. At lower concentrations the λ-transition and phase separation curves coincide substantially with those of others, e.g. Walters and Fairbank, whereas at higher concentrations the curves are shifted to somewhat higher temperatures. Another experiment concerned the boundary between He I and He II when heat flowed through it. Under normal circumstances this boundary is invisible since the λ-transition is a second order transition and hence shows no discontinuity in the density. By means of an optical system interference fringes were observed in a He^4-filled, wedge-shaped glass vessel with a heater at one side. If at a temperature below the λ-point sufficient heat was put in, the temperature rose and finally passed the λ-point. At this moment a boundary in the vessel appeared, resulting in a shift of the interference lines. Since the shift is proportional to the change in density, the density jump at this boundary and the corresponding temperature jump could be calculated. The density jump was proportional to the square of the heat flow. Hence the transition of He I into He II in the presence of a heat flow is no second order transition any more, but merely a special first order or a zero order transition. For larger heat inputs the transition becomes very complicated: for a heat current density of 0.08 W/cm^2 the temperature in the He I-region first falls, then rises 0.02° and falls once more 0.03°, when approaching the boundary. Photographic observation of the boundary reveals the existence of superfluid whirls entering into the He I-region. Further investigations of these boundary phenomena will be of interest, since here a quantum liquid (He II) interacts with an ordinary classical liquid.

536.48

8922 VORTICITY IN SUPERFLOW.
S.M.Bhagat and K.Mendelssohn.
Physica, Vol. 24, Supplement, S147 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Isothermal flow of liquid He II through a capillary of 276 μ diameter and 150 cm length has been measured. The liquid was first passed through a Vycor glass filter in which the flow was always subcritical. For low pressure heads the flow through the capillary was completely pressure independent and the critical velocity changed with temperature somewhat like ρ_s/ρ. At higher pressures, dissipation was observed which, once it had set in, was maintained to low pressures. Shortening of the capillary to 17.6 cm resulted in much (~ 5 times) smaller, pressure dependent velocities. Moreover, the pressure dependency of the flow rate became very complicated, first decreasing with falling $\Delta\rho$ and then suddenly increasing again. A sensitive explanation of the observed phenomena on the basis of vortex formation is suggested.

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8923 PHENOMENOLOGICAL ASPECTS OF THE λ-TRANSITION. G.Borelius.
Physica, Vol. 24, Supplement, S183 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). See Abstr. 3391 (1959).

536.48

8924 ON THE POSSIBLE SUPERFLUIDITY OF LIQUID ^{3}He. L.N.Cooper, R.L.Mills and A.M.Sessler.
Physica, Vol. 24, Supplement, S183 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The possible superfluidity of a system of strongly interacting fermions is investigated on the assumption that an adequate description of the system in its "normal" state is given by independent fermions in a momentum dependent potential. On the basis of this assumption, an investigation to determine whether a correlated wave-function of the form used by B.C.S. minimizes the ground-state energy has been carried out. The non-zero terms in the expectation value of the Hamiltonian contain the modified kinetic energy and the full two-body potential between the singlet, zero momentum pairs. An integral equation in configuration space for the correlation function between pairs is then obtained. This integral equation is meaningful even for potentials with hard cores, and a non-zero solution implies the existence of a superfluid state. A variational method has also been devised which provides a

lower bound for the transition temperature into the superfluid state. It is found that a hard core does not in principle forbid the existence of a superfluid state. For He^3 any T_c is expected to be very low, but whether or not T_c exists has not yet been established.

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8925 ON SUPERCONDUCTIVITY. J.A.Kok.
Physica, Vol. 24, No. 12, 1045-50 (Dec., 1958).

Deals with a two-component theory of superconductivity. At temperatures below the normal transition point the superconductor is assumed to consist of two components. One of these is the normal metal whereas the second has a slightly larger volume $V + \Delta V$. The equilibrium between the electrons in the two states may be possible via the lattice vibrations. Some speculations are made on the normal transition temperature and on the question of what metals will become superconductive.

536.48

8926 SURFACE IMPEDANCE OF A SUPERCONDUCTOR IN A MAGNETIC FIELD. G.Dresselhaus and M.S.Dresselhaus.
Phys. Rev., Vol. 118, No. 1, 77-91 (April 1, 1960).

Explicit expressions for the static magnetic field variation of the surface impedance in a superconductor are derived. Detailed consideration is given to the two limiting cases of the classical skin effect and of the extreme anomalous skin effect, with the static field either parallel or perpendicular to the r.f. current. The transport calculation is carried out for a two-fluid model with the supercurrent obeying the London equation and the normal current following a non-local relation. It is suggested that a comparison between theory and the experimental data yields information on the energy band structure of normal electrons in the superconducting state.

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8927 THEORY OF SUPERCONDUCTING ALLOYS IN A STRONG MAGNETIC FIELD NEAR THE CRITICAL TEMPERATURE. L.P.Gor'kov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1407-16 (Nov., 1959). In Russian.

The equations of the phenomenological Ginzburg–Landau theory near T_c were deduced from the BCS theory. As in the case of pure superconductors a double charge is encountered in the equations. The relation between κ (a constant in Ginzburg–Landau's theory) of an alloy and κ_0 of a pure superconductor was found assuming that the shift in T_c is small. For a sufficiently "impure" alloy, κ depends only on the conductivity and the coefficient in the linear law of the electron specific heat of a normal metal. Agreement between theory and experiment is found to be satisfactory.

536.48

8928 THERMODYNAMICS OF THE λ-TRANSITION IN SUPERCONDUCTORS. G.Borelius.
Ark. Fys., Vol. 16, Paper 32, 337-48 (1960).

A two-fluid model is proposed which includes an entropy of mixing term of the form $\Delta S \propto -x \log x$, where x is the proportion of normal fluid. The model agrees well with experimental results for Nb, V and Sn. R.G.Chambers

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8929 ALLOWING FOR COULOMB EFFECTS IN THE THEORY OF SUPERCONDUCTIVITY. D.V.Skirkov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 179-86 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 127-31 (Jan., 1960).

By changing from the energy operator to the S-matrix, the compensation equation for dangerous electron diagrams is reduced to a symmetric form, which is expressed in terms of the usual Green's functions. In the high-density electron gas approximation, the summation of the Coulomb singularities in the kernel of the compensation equation is performed by the renormalization group method. In the lowest approximation, the result of the summation is the same as the formulae obtained previously by qualitative means.

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8930 ANALYSIS OF EXPERIMENTAL DATA RELATING TO THE SURFACE IMPEDANCE OF SUPERCONDUCTORS. A.A.Abrikosov, L.P.Gor'kov and I.M.Khalatnikov.
Zh. eksper. teor. Fiz., Vol. 37. No. 1(7), 187-91 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 132-4 (Jan., 1960).

The results of experimental measurement of the surface impedance of superconductors at various frequencies are compared with the new theory of superconductivity. Satisfactory agreement with the experiments has been found for all frequencies, excluding the very lowest. At low frequencies, the experimental values for the real part of the impedance near the critical temperature are several times larger than the theoretical values.

536.48

8931 MEASUREMENT OF THE PENETRATION DEPTH IN SUPERCONDUCTING HOLLOW BODIES.
R.Jaggi and R.Sommerhalder.
Helv. phys. Acta, Vol. 33, No. 1, 1-20 (1960). In German.

The penetration depth of magnetic fields in superconducting tin films was measured. The films, 400-2000 A thick, were evaporated in vacuo and had the form of hollow cylinders. A magnetic field of 60 c/s was externally applied parallel to the axis of the cylinder and the magnetic field which penetrated through the films into the interior of the hollow body was detected. It is found that there are departures from the law

$$\lambda(T) = \lambda(0)\,[1 - (T/Tc)^4]^{-1/2},$$

which are in agreement with Lewis' extension of the Casimir–Gorter two fluid model and with the theory of Bardeen, Cooper and Schrieffer. The absolute value of the London penetration depth at $T = 0°K$ is found to be $\lambda(0) = 700 \pm 100$ A for the thickest films and increases with decreasing film thickness.

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8932 SUPERCONDUCTING COMPUTER ELEMENTS. E.H.Rhoderick.
Brit. J. appl. Phys., Vol. 10, No. 5, 193-8 (May, 1959).

A survey is made of the present status of superconducting circuit components, including both active elements of the "cryotron" type and passive elements such as persistent current memory cells. The factors which affect the speed of operation of these devices are discussed, and the future shown to be closely linked with developments in the technology of thin metallic films.

536.48

8933 SUPERCONDUCTION OF EVAPORATED LEAD FILMS WITH Gd IMPURITY. K.Schwidtal.
Z. Phys., Vol. 158, No. 5, 563-71 (1960). In German.

The influence of the paramagnetic impurity gadolinium on the superconducting properties of lead was studied. Both components were forced to form an alloy by condensing them simultaneously from the vapour phase on a substrate at low temperature. The superconducting transition temperature (T_c) decreases linearly with increasing Gd content. For T_c v. Gd concentration, the measurements yield $dT_c/dc = -2 \times 10^3$ deg K. This result is discussed from the viewpoint of the theories of Baltensperger (Abstr. 12299 of 1959) and of Suhl and Matthias (Abstr. 9608 of 1959), and compared with results of other systems.

536.48 : 532.6

8934 MEASUREMENT OF SURFACE TENSION AT THE BOUNDARY BETWEEN SUPERCONDUCTING AND NORMAL PHASES OF INDIUM. Yu. V.Sharvin.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 298-300 (Jan., 1960). In Russian.

Measurements of surface tension σ_{ns} (Abstr. 5693 of 1958) are reported for temperatures between 2.11 and 3.245° K. The variation with temperature of the quantity $\Delta = 8\pi\sigma_{ns}/H_c^2$ is found to be $\Delta = 3.3 \times 10^{-5}(1 - T/T_c)^{-1/2}$, with $T_c = 3.40°K$. The results, together with earlier values for Al and Sn, are compared with the Ginzburg–Landau theory of superconductivity, and possible reasons for the observed discrepancies are suggested. R.F.S.Hearmon

536.48

8935 CRITICAL FIELD CURVE OF SUPERCONDUCTING MERCURY.
D.K.Finnemore, D.E.Mapother and R.W.Shaw.
Phys. Rev., Vol. 118, No. 1, 127-9 (April 1, 1960).

The critical field curve was measured precisely in a range of reduced temperature, $t = T/T_c$, from 1 to 0.27. The observed H_c values show an appreciable deviation from a parabolic temperature dependence, lying above the parabola which passes through the experimental values of H_0 and T_c. The general behaviour is similar to that previously observed in the case of lead (Abstr. 4620 of 1959).

Values of the temperature coefficient of the normal electronic specific heat, γ, are derived, but are somewhat uncertain since the H_c data indicate an appreciable entropy contribution from the superconducting electrons at the lowest temperature of measurement. The qualitative behaviour of H_c (T) for lead and mercury is in accord with recent infrared measurements which give direct indication that the energy gap value for these elements is anomalously large.

536.48

8936 THE VARIATION WITH FREQUENCY OF THE RESISTANCE OF SUPERCONDUCTING TIN AND INDIUM. M.D.Sturge.
Proc. Roy. Soc. A, Vol. 246, 570–81 (Aug. 26, 1958).

The ratio of the superconducting to the normal resistance of tin has been measured calorimetrically at frequencies between 220 and 8500 Mc/s, as a function of temperature, crystal orientation, and purity. Near the transition temperature the resistance varies with frequency in the way predicted by the two-fluid model. At lower temperatures the absolute resistance is roughly independent of purity and orientation. The predicted variation as the square of the frequency is observed up to 1500 Mc/s, but at higher frequencies the resistance varies more slowly. It is shown that this deviation from the square law can be explained by taking relaxation of the normal fluid into account only if the normal fluid is not a Fermi gas. The insensitivity of the superconducting resistance to impurity is shown to be evidence against the theory of Schafroth and Blatt (1956). Some approximate measurements on indium indicate that the superconducting resistance varies as the square of the frequency up to 5000 Mc/s.

536.48

8937 THE THERMAL CONDUCTIVITY OF TIN AND INDIUM BELOW 1°K. G.M.Graham.
Proc. Roy. Soc. A, Vol. 246, 522–38 (Dec. 9, 1958).

An experimental study has been made of some aspects of the thermal conductivity of superconducting tin and indium below 1°K. Experiments at the lowest temperatures, where the thermal conductivity of the lattice is dominant, and for tin varies as T^3, have been mainly directed towards studying the size effect in the conductivity due to the scattering of phonons at the specimen surface. Electropolishing tin has been found to increase the thermal conductivity considerably; a simple analysis of the results shows that almost complete specular reflection of phonons is attainable. The analysis confirms the existence of an internal scattering of phonons, describable at the lowest temperatures by a temperature-independent mean free path which does not vary when the diameter of the specimen is reduced, but is very sensitive to any damage suffered by the crystal. The lattice conductivity of indium, which is anomalous in having a T^4 rather than a T^3 variation, appears to be limited mainly by internal scattering and it is tentatively suggested that the internal scattering is mainly due to the re-radiation from dislocations oscillating in the phonon field. At somewhat higher temperatures (above about 0.7 but below 1°K) the thermal conductivity is predominantly electronic and the results indicate that here too the "effective" electronic mean free path is size-dependent due to boundary scattering. From an analysis of this size-dependence in tin, the "intrinsic" electronic mean free path in the superconducting state is deduced and found to be between ten and thirty times as long as in the normal state. The results suggest also that the electronic velocity in the superconducting state is something like one-third of the Fermi velocity.

536.48

8938 THE THERMAL CONDUCTIVITY OF SOME SUPERCONDUCTORS. P.M.Rowell.
Proc. Roy. Soc. A, Vol. 254, 542–50 (March 8, 1960).

The thermal conductivities of single crystals of lead, niobium and a lead-bismuth alloy were measured between 1° and 4° K in the superconducting state. At temperatures near 1° K the conduction is mostly by lattice and the effect of plastic deformation on this conduction mechanism was investigated. This has shown that deformation greatly reduces the magnitude of the conductivity and that its temperature dependence changes from T^3 to values nearer T^2 for niobium and the lead alloy but remains unchanged for pure lead. It is suggested that these changes in conductivity are due to the scattering of lattice waves by isolated dislocations, and an attempt has been made to correlate the densities of dislocations obtained from thermal conductivity measurements with those obtained from a knowledge of the amount by which the specimen was deformed.

536.48

8939 SUPERCONDUCTIVITY OF TIN, LEAD AND THALLIUM UP TO 10 000 ATMOSPHERES. D.H.Bowen and G.O.Jones.
Proc. Roy. Soc. A, Vol. 254, 522-36 (March 8, 1960).

In a development of the clamp technique of Chester and Jones (Abstr. 414 of 1954), virtually hydrostatic pressures of up to 10 000 atm have been attained in soft metal specimens at low temperatures. Measurements of the variation with pressure of the superconducting critical temperatures of tin, lead and thallium in zero magnetic field are in agreement with measurements made by other methods and the change in sign of the pressure effect in thallium is confirmed. Critical field measurements at 9400 atm support the conclusion that the density of states in tin is not appreciably changed by compression and the implications of this observation are discussed in relation to the theory of superconductivity.

536.48

8940 DESTRUCTION OF SUPERCONDUCTIVITY IN THIN FILMS BY FIELD AND CURRENT.
N.I.Ginzburg and A.I.Shal'nikov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 399-405 (Aug., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 285-9 (Feb., 1960).

Measurements were made on the critical magnetic fields and currents required to destroy superconductivity in thin cylindrical tin films. Qualitative agreement with the Ginzburg–Landau theory was obtained. The structure of the films studied is discussed.

536.48

8941 THE CRITICAL SUPERCOOLING FIELD IN SUPERCONDUCTIVITY THEORY. L.P.Gor'kov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 833-42 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 593-9 (March, 1960).

The magnitude of the critical supercooling field H_{c1} is determined. It is found that H_{c1} is larger than, or smaller than the critical field. H_c, depending on whether the superconductor in a weak field is of the London or of the Pippard type. The superconductor in the first case must behave in a strong field similarly to alloys. The magnitude of the ratio H_{c1}/H_c depends weakly on the temperature in the whole temperature range.

536.48

8942 ROLE OF SURFACE ENERGIES IN SUPERCONDUCTIVITY. V.L.Ginzberg.
Physica, Vol. 24, Supplement, S42-S47 (Sept., 1958).

A review of the Ginsburg–Landau theory (Abstr. 2894 of 1956).
R.G.Chambers

536.48

8943 THE INTERACTION IN THE B.C.S. THEORY OF SUPERCONDUCTIVITY. J.C.Swihart.
Physica, Vol. 24, Supplement, S147 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: If in the B.C.S. interaction (Abstr. 1708 of 1958) ϵ_k and $\epsilon_{k'}$ are not set equal to zero, the ground state wave-function can be determined without limiting the interaction to a region $2\langle\hbar\omega_X\rangle_{AV}$ wide at the Fermi surface. A variation of the total energy with respect to h_k leads to an integral equation for $\epsilon_0(k)$ which is now a function of k. The ϵ_0 thus determined minimizes the energy as long as $\epsilon_0 \geq 0$. For k such that the integral equation gives $\epsilon_0 < 0$, the energy is minimized by $h_k(1 - h_k) = 0$. The strength of the interaction and the size of the region in k-space over which it is effective are not independent quantities but both are determined by the critical temperature.

536.48

8944 A THEORY OF SUPERCONDUCTIVITY. R.Kikuchi.
Physica, Vol. 24, Supplement, S147 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Applying Feynman's path integral technique to the system of electrons and phonons, one can first integrate over phonon coordinates to derive virtual interaction among electrons. Then if the electron–phonon interaction is strong enough compared with the Coulomb interaction among electrons, a contribution to the partition function becomes large when a pair of electrons located close to each other are permuted with another pair lying side by side. This is called a parallel permutation. Permutations form polygons in the coordinate space. Double polygons made

of parallel permutations can be regarded as "Bose" particles. Superconducting state is interpreted as a Bose-condensed state of these "Bose" particles. This picture has a close similarity with that of Schafroth, Butler and Blatt. This is also related to the recent work on statistical mechanics of Montroll and Ward.

536.48

8945 SUPERCONDUCTIVITY. J.A.Kok.
Physica, Vol. 24, Supplement, S147-S148 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A superconductor is supposed to consist of two components of atomic volumes V₁ and V + ΔV (Lasarev). The expansion results in an unimportant change in θ (Lindemann) and the zero temperature lattice energy. The decrease ΔG_0 in the zero temperature thermodynamic potential G_0 of the electrons (Sommerfeld) is more important and corresponds to the energy difference involved in superconductivity. If A is the atomic weight:

$$\frac{\Delta\theta}{\theta} = -\frac{1}{3}\frac{\Delta V}{V} - \frac{1}{2}\frac{\Delta A}{A}.$$

For free electrons it follows:

$$-\frac{\Delta V}{V} = \frac{3}{2}\frac{\Delta G_0}{G_0}.$$

The isotope effect may be derived. A modified distribution function gives the specific heat below the transition point. However, in this case the correction $c_p - c_v$ is important. Thermodynamically the two-component system resembles the system ice-water. Some speculations may be made as to the normal transition temperature and the question of which metals will become superconductive.

536.48

8946 SUPERCONDUCTIVITY. B.Matthias.
Physica, Vol. 24, Supplement, S148 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: New experimental results and conclusions as to the occurrence of superconductivity are presented. Ferromagnetism in compounds of superconducting elements is no longer hypothetical.

536.48

8947 SPECIFIC HEAT OF GALLIUM AND ZINC IN THE NORMAL AND SUPERCONDUCTING STATES. P.H.Keesom and G.Seidel.
Physica, Vol. 24, Supplement, S148 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The specific heat of gallium and zinc has been measured in the range 0.35–4.2°K, temperatures below 1°K being obtained by pumping on a bath of liquid He^3. The results of these measurements are:

	$\theta(0°K)$	γ	T_c	$\frac{C_{es}}{\gamma T_c}T_c$	a	b
	°K	$\frac{\text{milli joules}}{\text{mole }(°K)^2}$	°K			
Ga	322	0.605	1.087	2.38	6.77	1.34
Zn	302	0.630	0.86	2.35	7.2	1.3

a and b are the coefficients in the expression for the electronic specific heat, C_{es}, in the superconducting state $C_{es}/\gamma T_c = a\,e^{-bT_c/T}$ for $T_c/T > 1.6$. The results for Ga are more satisfactory than those for Zn since the transition from the normal to the superconducting state was sharper and also larger values of T_c/T were obtained for Ga. Comparing these measurements with those made on other superconductors, it appears that the law of corresponding states is not strictly valid.

536.48

8948 THE SUPERCONDUCTING ELECTRONIC SPECIFIC HEAT OF NIOBIUM AT LOW REDUCED TEMPERATURES. H.A.Boorse and A.Hirshfeld.
Physica, Vol. 24, Supplement, S148-S149 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The Bardeen, Cooper and Schrieffer theory of superconductivity predicts an exponential dependence for the reduced superconducting electronic specific heat $C_{es}/\gamma T_c$, and a law of corresponding states. Goodman's experimental data for tin and aluminium indicate departures from the exponential dependence. All the data presently available lead to more serious doubt regarding the law of corresponding states. Measurements of $C_{es}/\gamma T_c$ for niobium may be readily made to low reduced temperatures and hence are especially useful as a check on the theory. New measurements have been made on a carefully heat-treated sample of this metal, and, contrary to results so far published for superconductors at low reduced temperatures, the B.C.S. equation $C_{es}/\gamma T_c = a\exp(-bT_c/T)$ is strictly followed at least to $T_c/T = 5$. The a and b values, however, differ substantially from the theoretical values of 8.5 and −1.44, being 10.0 and −1.63. Other measured values were $T_c = 9.08°K$, $\Theta = 231°K$ and $\gamma = 18.2 \times 10^{-4}$ cal/mol^{-1} deg^{-2}.

536.48

8949 MEASUREMENTS OF THE GYROMAGNETIC EFFECT ON SUPERCONDUCTING LEAD-SPHERES OF MACROSCOPIC AND MICROSCOPIC DIMENSIONS. R.Doll.
Physica, Vol. 24, Supplement, S149 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). See Abstr. 4793 (1959).

536.48

8950 NUCLEAR SPIN–LATTICE RELAXATION TIME IN SUPERCONDUCTING ALUMINUM. A.G.Redfield and A.G.Anderson.
Physica, Vol. 24, Supplement, S150 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The nuclear spin–lattice relaxation time τ_1 has been measured from 0.6 to 1.2°K in pure aluminium by the method of Hebel and Slichter (Abstr. 192 of 1958) using techniques described by Redfield. τ_1 drops continuously from the normal value of 0.55 sec at the critical temperature, T_c, to 0.25 ± 0.02 sec at 0.065 degree below T_c. τ_1 has a value of 0.26 ± 0.08 sec at 1.05° and is roughly proportional to T^{-1} down to 0.8°, below which it increases more rapidly, being 1.25 ± 0.45 sec at 0.6°. Below 0.6° the temperature is uncertain because of the magnetocaloric effect, but τ_1 becomes of the order of 15 sec at 0.4°. These observations are consistent with a gap model, as discussed by Hebel and Slichter, and are in reasonable agreement with their calculation of τ_1 based on the Bardeen, Cooper and Schrieffer theory, assuming an electronic level width of about $0.02\,kT_c$.

536.48

8951 THE VELOCITY OF A CYLINDRICAL PHASE-BOUNDARY BETWEEN NORMAL- AND SUPERCONDUCTOR IN A CIRCULAR MAGNETIC FIELD. BY EXPERIMENT AND THEORY. M.Nihauer.
Physica, Vol. 24, Supplement, S150 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). See also Abstr. 321 (1959). Brief note, substantially as follows: In previous experiments the behaviour of a superconducting hollow cylinder of lead was investigated in a circular, magnetic field, switched on and overcritical at the inner surface of the cylinder, but smaller than the critical field at the outer surface. In this case a transition from super- to normal conductivity begins at the inner surface of the hollow cylinder and a cylindrical phase boundary moves into the metal. The velocity of the cylindrical phase boundary was computed theoretically, taking into account the thermal effects during the transition and the time dependence of the magnetic field, which does not reach its final value immediately after being switched on but after a short time. The computed velocities are compared with the measurements. They agree for times $t > 3 \times 10^{-3}$ msec, if $t = 0$ is the time when the field at the inner surface of the hollow cylinder has reached the critical value; for $t < 3 \times 10^{-3}$ msec there is a discrepancy, which is discussed.

536.48

8952 A CYCLIC SUPERCONDUCTING REFRIGERATOR. P.R.Doidge.
Physica, Vol. 24, Supplement, S150 (Sept., 1958).
Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The cyclic destruction of superconductivity is a feasible method of continuous refrigeration to temperatures below 1°K provided precautions are taken to eliminate eddy current heating. The effects of laminating the superconducting

working substance and of introducing impurity are discussed. Certain other practical problems which have been met in the construction of such a refrigerator are described.

536.48

8953 SLOTS IN THE SURFACE OF A SUPERCONDUCTOR. G.U.Schubert.

Physica, Vol. 24, Supplement, S151 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Some rigorous solutions of the London equations are given to examine the influence of slots in the surface of a superconductor on the distribution of currents. The magnetic field is longitudinal. The cross-sections of the slots are: parabola in the full plane, semi-circle and semi-ellipse in the half-plane.

536.48 : 534.23

8954 ULTRASONIC ABSORPTION IN SUPERCONDUCTING AND NORMAL MERCURY. L.Mackinnon and A.Myers.

Physica, Vol. 24, Supplement, S151 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The absorption of 10 Mc/s longitudinal ultrasonic waves in superconducting and normal mercury has been studied over the liquid helium temperature range (i.e., down to about 1.1°K). The difficulties which arise when attempts are made to correlate these results with the Bardeen, Cooper and Schrieffer theory of superconductivity are discussed; apart from the theory, magnetic field effects make it difficult to estimate the absorption in the normal metal in zero field. This absorption is not constant over the temperature range of interest, which is an additional complication.

536.48 : 539.2 : 548.5

8955 THE PREPARATION AND PURIFICATION OF TANTALUM SINGLE CRYSTALS AND MEASUREMENTS OF THE CRITICAL FIELD CURVE FOR SINGLE AND POLYCRYSTALLINE SPECIMENS. J.I.Budnick, W.B.Ittner and D.P.Seraphim.

Physica, Vol. 24, Supplement, S151 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Single crystal wires of tantalum have been grown up to 3 in. in length by a strain anneal process. Both single crystal and polycrystalline specimens have been outgassed in very high vacua with pressures ranging down to about 2×10^{-10} mm Hg. This outgassing produced samples of considerably greater purity than had previously been reported. Values up to 700 for the ratio of room temperature resistance to normal state resistance at 4.2°K have thus been obtained. The transition temperature is found to increase with increasing purity, up to a value of 4.476°K for the purest specimen. Some samples were found to have very sharp resistive transitions and to have a relatively low (−322 gauss/°K) slope for H_c versus T near T_c.

536.48

8956 VOLUME CHANGES IN HARD SUPERCONDUCTORS. H.Rohrer.

Physica, Vol. 24, Supplement, S152 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The change in length on destruction of superconductivity by magnetic fields in the temperature range 1.5 to 4.2°K was investigated. An optical lever arrangement allowed changes in length of 1 part in 10^8 to be observed with an accuracy of 2-10% on specimens 10 cm long. The accuracy of previously published measurements (Abstr. 8636 of 1957) on V and Ta have been improved and extended to measurements on La and Nb. The apparatus is described and the experimental results compared with recent theoretical work.

536.48

8957 THE EFFECT OF IMPURITIES ON THE CRITICAL TEMPERATURE OF ALUMINUM AND INDIUM. E.A.Lynton and B.Serin.

Physica, Vol. 24, Supplement, S152 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements of the critical temperature of both aluminium and indium alloys indicate a qualitative behaviour strikingly similar to that reported for impure tin samples [J. Phys. Chem. Solids, Vol. 3, 165 (1957)]. For sufficiently small amounts of all solutes T_c again decreases, and it is believed that this is a repetition of the mean free path effect noticed in tin. With increasing impurity T_c varies more complicatedly in a manner also resembling the previous results: the curves of T_c v. impurity concentration tend to fall into groups according to the valence difference between solvent and solute. For higher valence solutes T_c has a sharp upward trend; for those with lower valence the curves tend to flatten out. The similarity of these impurity effects for different solvents suggest that they are a fundamental property independent of the detailed nature of the superconductor.

536.48

8958 SUPERCONDUCTIVITY OF VANADIUM ALLOYS. G.Busch and J.Muller.

Physica, Vol. 24, Supplement, S152 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). See also Abstr. 12300 (1959). Brief note, substantially as follows: Very pure samples of vanadium alloys containing small amounts of chromium, titanium and cobalt have been obtained by simultaneous thermal dissociation of the iodides. The superconducting transition temperatures and critical magnetic fields have been measured as a function of the concentration. In the chromium alloy series, the transition temperature shows a rapid decrease and vanishes at approximately 8% Cr. With the addition of cobalt, the decrease of the transition temperature occurs at considerably lower solute concentrations. These results can be explained by considering the exchange interaction of the conduction electrons with the 3d electrons (see following abstract). Similarly, as already reported for pure V [Helv. phys. Acta, Vol. 30, No. 4, 230 (1957)], in those alloys for which an accurate determination of the critical field was possible, this field shows deviations up to four or five % from the parabolic form. These deviations are in agreement with the theoretical prediction of Bardeen et al.

536.48

8959 ON THE INFLUENCE OF EXCHANGE ON SUPERCONDUCTIVITY IN AN ALLOY WITH A TRANSITION METAL. W.Baltensperger.

Physica, Vol. 24, Supplement, S153 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960) Brief note, substantially as follows: Exchange between conduction electrons and electrons from incomplete inner shells is important in alloys of a superconductor with a transition metal. This interaction is of the right order to explain the behaviour of the vanadium alloys investigated in the preceding abstract. The response of the thermodynamical properties of the system as described by Bardeen et al. to an additional interaction is examined using a model which removes the spin degeneracy of the electronic energy levels. As a result the transition temperature decreases, the H_c v. T^2 curve tends to bend outward, and the transition becomes of the first kind even in the absence of a magnetic field.

536.48

8960 SUPERCONDUCTIVITY OF INDIUM–LEAD ALLOYS. S.Gygax.

Physica, Vol. 24, Supplement, S153 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The critical magnetic fields of In–Pb alloys containing up to 10% Pb have been investigated. Both the magnetic and the resistive properties were investigated. The relation between change in critical temperature and of electronic specific heat is discussed with particular reference to the Bardeen theory. These alloys show good mechanical properties and some have transition temperatures only slightly above 4.2°K. Their applications in superconducting circuits and in particular to a d.c. amplifier is described.

536.48 : 539.2 : 538.2

8961 THE PARAMAGNETIC EFFECT IN SUPERCONDUCTORS AT LOW VALUES OF THE EXTERNAL FIELD. H.Meissner.

Physica, Vol. 24, Supplement, S153 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The following discrepancies between experiment and theory (Abstr. 6020 of 1956) of the paramagnetic effect are known: (a) The effect disappears below a certain minimum current I_{K_0}. (b) The effect disappears at low values of the external field H_{z_0}. The object of this research is to look for a correlation between (a) and (b). Measurements on a single crystal of tin have shown that in a very pure sample the paramagnetic effect can be observed even at fields below 0.01 A/cm, although the magnitude is very small. The time for the establishment of the flux becomes very large (up to 10 minutes). This is in accordance with the

conjecture (see Abstr. 8786 of 1958) that even at $H_{Z_0} = 0$ the domains are long and thin, and form (at $H_{Z_0} = 0$) almost closed rings which have a large time constant. Below $H_{Z_0} = 0.4$ A/cm the evaluation of K_m is hindered by uncertainties in the accounting for stray fields. The usual plots of K_m v. I and of I_0 v. H_{Z_0} are therefore somewhat doubtful in the region of interest. (K_m is the maximum permeability, I the sample current, and I_0 its value at $K_m = 1$). A plot of $(K_m - 1)H_{Z_0}/H_C$ v. H_{Z_0}/H_C is almost free of these uncertainties. Such plots are now being studied in the hope of elucidating the discrepancies at low values of H_{Z_0} and I. Although the present data are still rather scant, it seems to be justified to state that a large value of I_g does not imply large deviations at low values of H_{Z_0}.

536.48

8962 RANGE OF ORDER OF SUPERCONDUCTING ELECTRONS IN NORMAL CONDUCTING BARRIERS.

W.R.Callahan and H.Meissner.

Physica, Vol. 24, Supplement, S154 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: It has been found (see Abstr. 8789 of 1958) that an interposed normal conducting barrier does not necessarily prevent the superconductivity of a contact between two superconducting wires. This gives rise to the assumption that the density of the superconducting electrons in the normal conducting barrier decreases relatively slowly with distance from the superconductor. Therefore observations of the barrier thickness at which superconductivity disappears provide an estimate of the "range of order" of the superconducting electrons. Previous measurements on copper plated tin wires have now been extended to nickel- and gold-plated tin wires. Experiments with other barrier materials are in progress. While gold, similar to copper, allows superconductivity up to thicknesses of 1000 to 2000 A, superconductivity is already quenched by nickel of a thickness of 100 A. This might be due to the fact that at about 75 A the saturation magnetization of the nickel film becomes large enough to quench superconductivity in the neighbourhood of the contact. A variation of the contact load from 60 to 900 g (weight) hardly influences the magnitude of the critical current in agreement with the theoretical predictions.

536.48 : 539.14

8963 SOME ASPECTS OF THE NUCLEAR ORIENTATION WORK AT OXFORD. N.Kurti.

Physica, Vol. 24, Supplement, S154 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Reports the use of dilute nickel zinc fluosilicate as a cooling agent to re-examine the radioactive decay of Co^{60}, Co^{58}, Mn^{56} and Mn^{54}. The main object of this work was to establish the suitability of dilute nickel fluosilicate as material for aligning nuclei of divalent ions of the iron group and to clear up a number of discrepancies. Thus, for instance, the experiments on Co^{58} showed that the β-decay was pure Gamow–Teller. Further developments on the use of nuclear orientation techniques in the study of crystal defects are also reported. The anisotropy of gamma emission from oriented radioactive nuclei produced by slow neutron capture at liquid air temperature has been studied as a function of annealing temperatures. The author and M.V.Hobden have constructed a new apparatus for nuclear cooling comprising a He^3 cryostat as thermal shield,and have carried out various experiments with it.

536.48

8964 SPIN EXCHANGE IN SUPERCONDUCTORS. C.Herring.

Physica, Vol. 24, Supplement, S184 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: It seems likely that the marked lowering of the superconducting transition temperature T_C of lanthanum by small additions of other rare earths (Abstr. 8946 of 1960) is due to the exchange coupling of the conduction electrons with the spins of the paramagnetic impurity ions. This coupling polarizes the conduction electrons near each impurity ion, the polarization dying off rapidly with increasing distance. The lowering of energy which the conduction electrons achieve by polarizing their spins in this way is almost, but not quite, the same for the normal and superconducting states. A simple calculation of the energy lowering can be made by second-order perturbation theory; the only transitions which give significantly different contributions for the normal and superconducting states are those for which initial and final energies of the electron are within something like an energy-gap distance of the Fermi surface. These transitions contribute to the energy lowering of the normal state much more than to that of the superconducting state and thus increase the relative stability of the former. The exchange coupling constant required to erase the superconductivity completely with 1% Gd turns out to have a very reasonable order of magnitude. Qualitative predictions of this model are that the lowering of T_C should be linear in the concentration of the solute and that it should vary as $S(S + 1)$, where S is the spin of the solute.

536.48 : 536.3

A SUPERCONDUCTING BOLOMETER AND SPECTROMETER FOR THE FAR INFRA-RED. See Abstr. 8837

536.48

8965 PROPOSAL FOR A METHOD OF NUCLEAR MAGNETIC COOLING UTILIZING ELECTRON SPIN RESONANCE. C.Kittel.

Physica, Vol. 24, Supplement, S88–S89 (Sept., 1958).

It is suggested that nuclear orientation may be achieved through the Overhauser effect, by saturating the electron spin resonance at about 0.5°K in a field of 10^4G. On removal of the r.f. and steady fields, the sample should cool to about 10^{-7} deg K.

R.G.Chambers

536.48

8966 VERY LOW TEMPERATURES OBTAINED BY INDIRECT COOLING.

A.R.Miedema, H.Postma and M.J.Steenland.

Physica, Vol. 24, Supplement, S180 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Heat transport from a single crystal of CrK-alum (1.5 g) to a solution of chromium nitrate in propyl alcohol (12 cm^3) has been measured. The CrK-alum crystals was glued to a copper plate (contact surface 2 cm^2). The thermal contact between the opposite end of the copper heat-link and the cooling agent consisted of 130 copper wires with a total surface of 70 cm^2. The temperature of the CrK-alum crystal varied between 0.5°K and 0.04°K. At relatively high temperatures the heat transport could be described by $Q = 26 \times 10^{-4}(T_H^2 - T_L^2)$ erg sec^{-1}, at the lowest temperatures by $Q = 12 \times 10^4 (T_H^4 - T_L^4)$ erg sec^{-1}, and at intermediate temperatures by a combination of these two formulae. The first formula corresponds to $K_{copper} = 0.42$ T W cm^{-1} $degree^{-1}$. In further experiments the CrK-alum crystal has been replaced by some single crystals of CeMg-nitrate (0.3 g) containing three microcuries of Co^{60}. From the γ-anisotropy in a polarizing field of 150 Oe it was deduced that the temperature was lowered within 6 minutes from about 0.1°K to $0.015 \pm 0.002^\circ$K. This method of indirect cooling has been applied to experiments on Ho^{166} in yttrium ethyl sulphate. (See Abstr. 9561 of 1960).

536.46

8967 DESIGN OF A HELIUM-LIQUEFYING CYCLE WITH EXPANSION ENGINES CONNECTED IN CASCADE. P.L.Kapitsa.

Zh. tekh. Fiz., Vol. 29, No. 4, 427-32 (April, 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 4, 377-82 (April, 1959).

The problem of the most effective cascade connection of expansion engines in a cryogenic cycle is solved. General expressions are derived for the determination of the temperature levels at which the expansion engines operate effectively. It is shown that if the efficiencies of the expansion engines differ only slightly, the most favourable conditions of operation are those in which the same amount of gas enters each of the engines. An expression is derived for determining the optimum number of expansion engines in the cycle. A quantitative analysis is made of a cycle for cooling a stream of helium from room temperature to a temperature close to that at which it liquefies.

ELECTRICITY

ELECTRICAL MEASUREMENTS

537.7 : 621.317.39

8968 SHIELDED COAXIAL LEADS FOR LOW-TEMPERATURE ELECTRICAL MEASUREMENTS. N.L.Brown and R.N.Barfield.

Rev. sci. Instrum., Vol. 31, No. 5, 517-19 (May, 1960).

The problem of making electrical contact to apparatus at very low temperatures is discussed, with particular reference to dielectric constant measurements in a situation where multiple shielding is required. Examples are given of easily constructed rigid electrode leads suitable for use at low temperatures, which have low thermal conduction, low and stable inter-conductor capacitance and conductance, and which provide for more than two coaxial conductors.

537.7 : 621.317.715

8969 TUNABLE GALVANOMETER AMPLIFIER. R.M.Huey and B.J.Lancaster.
J. sci. Instrum., Vol. 37, No. 4, 136-8 (April, 1960).

The construction and performance of a tunable galvanometer amplifier using a photomultiplier tube are described. A tuning range of a little over two octaves with resonant voltage gains of over 10^4 times and Q-values ranging from 1.7 to 7.5 were obtained.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

537.2

8970 A METHOD FOR DETERMINING THE COMPLEX PERMITIVITY OF DIELECTRICS AT VERY LOW FREQUENCIES. H.Martinot.
C.R.Acad. Sci. (Paris), Vol. 249, No. 25, 2734-6 (Dec. 21, 1959). In French.

Describes a potentiometer method for the simultaneous measurement of the current through a specimen and of the applied voltage, at frequencies between 1 and 10^{-3} c/s. Evaluation of ϵ' and ϵ'' from these measurements is shown theoretically. J.H.Mason

537.2

8971 SERIES EXPANSION OF A CYLINDRICAL POTENTIAL IN THE VICINITY OF A BOUNDARY CONTAINING VOLUME DISTRIBUTION OF CHARGES AND DERIVATION OF THE FINITE DIFFERENCE EQUATION. P.Durand.
C.R.Acad. Sci. (Paris), Vol. 250, No. 7, 1189-91 (Feb. 15, 1960). In French.

Extension of the method, developed previously by the author (Abstr. 5253 of 1960) for a surface distribution of charges, to a volume distribution. J.K.Skwirzynski

537.2

8972 DEVELOPMENT IN SERIES OF THE POTENTIAL IN THE VICINITY OF A RECTANGULAR CORNER OF A DIELECTRIC, AND APPLICATION TO THE SETTING UP OF A FINITE-DIFFERENCE EQUATION. P.Durand.
C.R.Acad. Sci. (Paris), Vol. 250, No. 11, 1983-5 (March 14, 1960). In French.

Formulae are derived which may be used in the numerical calculation of potentials in this particular problem. P.M.Davidson

537.2

8973 CHARGED SPHERE IN CYLINDER. W.R.Smythe.
J. appl. Phys., Vol. 31, No. 3, 553-6 (March, 1960).

The method first used to solve the problem of a freely charged right circular cylinder (see Abstr. 8159 of 1956), is applied to the case of a charged conducting sphere enclosed by a coaxial circular conducting cylinder. The charge density on the sphere, the potential between it and the cylinder and the capacitance are given for sphere to cylinder radius ratios of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 0.95. All results are accurate to one part in 10^7 or better. An approximate formula for the capacitance of a sphere in a cylindrical box is given.

537.2

8974 THE UNIPOLAR CORONA IN THE CASE OF AN ECCENTRIC CYLINDER. L.E.Tsŷrlin.
Zh. tekh. Fiz., Vol. 29, No. 5, 563-7 (May, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 5, 501-5 (Nov., 1959).

A detailed analytical treatment, in which the potential distribution for a wire-cylinder geometry is derived. The wire is internal and eccentric. Discharge parameters are not discussed. J.D.Craggs

537.2

8975 STATIC BOUNDARY PROBLEM FOR A HOLLOW CYLINDER OF FINITE LENGTH.
P.L.Kapitsa, V.A.Fok and L.A.Vainshtein.
Zh. tekh. Fiz., Vol. 29, No. 10, 1177-87 (Oct., 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 10, 1077-87 (April, 1960).

An analysis is given for the potential of a simple layer made up of charges distributed with a given density on a hollow cylinder of finite length (a section of a circular tube). The various methods are considered of solving the integral equations which relate the surface charge with the potential, (equations of this type appear in a number of important problems in mathematical physics). By representing the potential at the surface of the cylinder and the charge density by appropriate series the problem is reduced to an infinite system of linear equations; the numerical solution of this system can be obtained by iteration methods. The matrix elements for this system are calculated by integration of linear differential equations of fourth order and, for short cylinders, by summation of the series.

537.2 : 621.317.73

8976 DESIGN OF A SINGLE ELECTRODE CAPACITOR FOR USE WITH MOISTURE METERS AND SIMILAR APPARATUS. D.F.Leach and J.M.M.Neilson.
J. sci. Instrum., Vol. 37, No. 3, 77-80 (March, 1960).

Measurements of the capacitance of a single cylindrical electrode in air have been made for each of the three variables, length, radius and height above earth. The effect of surrounding it by dielectric masses of various sizes was also investigated, and the change of capacitance with increase in dielectric volume determined. The influence of these factors when designing a capacitor of this type is discussed. This electrode has been successfully used for measuring the moisture content of textile packages, and could be used for similar applications involving measurement of dielectric properties.

537.2

8977 ELECTRICAL EFFECTS OBSERVED WITH SOLID AND GASEOUS CO_2. S.Mascarenhas.
Z. Naturforsch., Vol. 15a, No. 2, 139-41 (Feb., 1960).

It has been shown that when solid carbon dioxide is formed by adiabatic expansion, a rather large charge separation occurs. Experimental results on the behaviour of the charged solid and of the gas to which it vaporizes are described. The charge per unit mass of the solid was measured in a Faraday-cage, and it was found to be of the order of -10^{-8}C/g. These charges decay from a maximum value of -5×10^{-8}C/g to a final value of -10^{-9}C/g in about 15 min. The gas resulting from the vaporization of the charged solid is similarly charged and its specific charge is about -10^{-10}C/g. C.F.Barnaby

537.2 : 621.315.61

8978 MODERN IDEAS ON THE BREAKDOWN OF DIELECTRICS. G.I.Skanavi.
Elektrichestvo, 1960, No. 2, 1-8 (Feb.). In Russian.

Examines physical processes involved in the breakdown of dielectric materials, and point out that these processes are closely bound up with structure, forces of interaction between particles, and conditions of the movement of charged particles in one or another medium. The breakdown of gaseous, liquid and solid dielectrics is discussed with reference to various modern theories and experimental results. 15 refs.
Associated Electrical Industries (Manchester)

537.2

8979 TIME-LAGS IN THE INTRINSIC ELECTRICAL BREAKDOWN OF GLASS. M.N.Azam and H.Dickinson.
Nature (London), Vol. 186, 146 (April 9, 1960).

Lead glass specimens failed at 11.4 ±1 MV/cm when tested in low conductivity water, to avoid the effects of edge discharges. Breakdown occurred after time delays varying between 10^{-7} and 10^{-4} sec. J.H.Mason

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

537.3

8980 DIRECT MEASUREMENT OF $\int i^2 \cdot dt$ BY A METHOD BASED ON THE HALL EFFECT.

S.C.Ryder-Smith, A.E.Guile and A.E.Barrington.
J. sci. Instrum., Vol. 37, No. 3, 100-3 (March, 1960).

A squaring unit based on the Hall effect is used to give an a.c output, the amplitude of which is proportional to the square of an input current. The input impedance is low, so that the unit may conveniently be fed from a shunt The output is amplified in a tuned amplifier, and fed through a rectifying circuit to an integrating instrument such as a fluxmeter, so that a direct reading of $\int i^2 \cdot dt$ is obtained. A modification is suggested to enable $\int e i dt$ to be measured, giving the arc energy in a circuit breaker or fuse. Thus, direct and immediate readings of these integrals can be obtained, and the need to apply time-consuming graphical techniques to records of the appropriate current or voltage waveforms is avoided. The accuracy is shown to be better than 2%.

537.3 : 621.315.2

8981 INDUCTANCE OF AN ECCENTRIC TUBULAR CONDUCTING SYSTEM. E.E.Jones.

Brit. J. appl. Phys., Vol. 10, No. 5, 230-2 (May, 1959).

The inductance is determined in a form suitable for easy application as a power series, having the distance between the axes of the two tubes as variable. The first three terms of the series are determined in closed form, and further approximations, if required, can be determined by solving in echelon certain ordinary simultaneous algebraic equations which sum up the boundary conditions of the problem. Numerical results are included in particular cases.

537.3 : 530.16

BROWNIAN MOTION OF A NON-LINEAR RC CIRCUIT CONSISTING OF A DIODE VALVE AND A CAPACITOR.
See Abstr. 8564

537.32

8982 APPARATUS FOR ACCURATE MEASUREMENT OF THERMOELECTRIC POWER. R.L.Eisner.

Rev. sci. Instrum., Vol. 31, No. 4, 462-4 (April, 1960).

The usual method, in which the specimen is clamped between copper blocks at two different temperatures is subject to errors, especially if the specimen is not in the form of a disk. In the apparatus described, the specimen is cylindrical and the whole change of temperature is made to occur in a short part of its length in the central region. P.M.Davidson

IONIZATION

537.56 : 539.18

8983 DETECTION OF METASTABLE ATOMS AND IONS. H.D.Hagstrum.

J. appl. Phys., Vol. 31, No. 5, 897-904 (May, 1960).

Experimental work is presented concerning the detection of metastable singly charged ions by means of electron ejection from contaminated metal surfaces. By the use of suitable retarding potentials one can cause the current of reflected ions to cancel very nearly the current of electrons ejected by the ground state ions. This method increases the ratio of metastable signal to background signal by a factor of 300 or more and is comparable to what can be done by modulation of the metastable component. Some comments concerning the detection of metastable atoms by means of Auger electron ejection processes are included.

537.56

8984 ENERGY PER ION PAIR FOR ELECTRON AND PROTON BEAMS IN ATOMIC HYDROGEN.

A.Dalgarno and G.W.Griffing.
Proc. Roy. Soc. A, Vol. 248, 415-28 (Nov. 25, 1958).

The angular distribution of electrons of given energy ejected by ionization of atomic hydrogen is calculated according to the Born approximation and used in conjunction with similar calculations by Bates, Dalgarno and Griffing of the cross-sections of other processes involving protons and atomic hydrogen to compute a mean specific energy per ion pair in a gas of atomic hydrogen for a beam consisting of protons and neutral hydrogen atoms in charge equilibrium, a range of beam energies from 10 keV to 3 MeV being covered. In contrast to previous theories, capture and loss are taken explicitly into account and it is shown that they cause a considerable extension of the range over which the mean specific energy is nearly constant. The mean specific energy per ion pair is also calculated as a function to impact energy for an electron beam with energies up to 1 keV. The results are in harmony with experimental data if the assumption is made that (at high energies) a hydrogen molecule is equivalent to two hydrogen atoms.

537.56

8985 FORMATION OF NEGATIVE HYDROGEN IONS ON AN INCANDESCENT TUNGSTEN SURFACE.

V.I.Khvostenko and V.M.Dukel'skii.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 651-3 (Sept., 1959)
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 465-6 (March, 1960).

The temperature dependence of the ratio of the negative-ion current to the electron current in the 2600-2900°K range yields a value of 0.8 ± 0.1 eV for the electron affinity of the hydrogen atom.

537.56

8986 H_1^- PRODUCTION BY HYDROGEN POSITIVE ION BOMBARDMENT OF A TUNGSTEN SURFACE.

L.P.Levine and H.W.Berry.
Phys. Rev., Vol. 118, No. 1, 158-66 (April 1, 1960).

A study of the energy distribution of the negative ions is described. 1 kV ions were used. The double mass spectrograph used allows analysis of both the incoming positive- and outgoing negative-ion beams. Two peaks are studied; a low-energy peak of negative hydrogen ions created by the bombardment of a dirty surface by an assortment of positive ions, and a high-energy peak of negative hydrogen ions created only under bombardment of a surface by H_2^+ and H_1^+. The height of the low-energy peak is found to be proportional to the amount of hydrogen on the surface. The curve has a peak 3 V wide at its half-maximum, and a tail 25 V long on the high self-energy side. The high-energy peak ranges from zero self-energy to a value resulting from a head-on collision between a proton in the incoming ion beam and one of the atoms in the surface. This curve is flat over its whole-energy range, dropping to zero at the low self-energy and independent of incident ion energy. On a clear surface the shape of this curve is independent of target temperature. The shape of the high-energy curve is compared with curves predicted by a random walk-collision theory and a theory based on the loss and gain, due to scattering, of particles in velocity groups. The shape of the low-energy curve is compared with curves predicted by a theory of thermal desorption of ions from a surface coupled with a mechanism for neutralization of ions as they leave the surface.

537.56

8987 STUDY OF THE IONS PRODUCED BY ELECTRON IMPACT IN WATER VAPOUR. M.Cottin.

J. Chim. phys., Vol. 56, No. 11-12, 1024-35 (Nov.-Dec., 1959).
In French.

H_3O^+, H_2O^+, OH^+, O^+, H^+, H^-, O^- and OH^- have been identified with the mass spectrometer during electron bombardment of water vapour, and the potentials at which these ions appear have been measured. These potentials are tabulated together with proposed mechanisms for formation of the ions. The results indicate the importance of three types of secondary reaction: thermal decompositions occurring on the filament of the electron emitter, dissociation of ions in the mass spectrometer by collision with residual gas molecules, and reaction between non-ionized molecules and the ions formed in the ionization chamber. Such "molecule-ion" reactions could also occur during radiolysis of water, and it would then be possible for the negative ion formed in the primary process to yield, not $H + OH^-$ uniquely but also $OH + H_2$ (or 2H) and an OH^- ion. C.B.Allsopp

537.56 : 539.19

IONIZATION AND DISSOCIATION OF SOME HALOGEN MOLECULES BY ELECTRON IMPACT. See Abstr. 7739

537.56

8988 RESONANCE MULTIPLICATION OF CHARGES ON POSITIVE POTASSIUM IONS.

Yu.F.Bydin and A.M.Bukhteev.

Zh. tekh. Fiz., Vol. 29, No. 1, 12-14 (Jan., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 1, 10-12 (Jan., 1959).

The effective cross-sections for this process were measured in the energy range 200-2000 eV. The results are compared with calculations made using Firsov's formula (Abstr. 5261 of 1952).

537.56

8989 TRANSPORT PHENOMENA IN SLIGHTLY IONIZED GASES : HIGH E"ECTRIC FIELDS. M.S.Sodha.

Phys. Rev., Vol. 118, No. 2, 378-81 (April 15, 1960).

For previous work, concerning low electric fields, see Abstr. 2326 of 1960. Starting with the electron velocity distribution obtained by Chapman and Cowling for a Lorentzian gas, in the presence of an electric field, the author has investigated the variation with electric field of a number of transport properties, arising from a magnetic field, perpendicular to the electric field and temperature gradient in the gas. The applicability of the results to semiconductors is also pointed out. A constant mean free path has been assumed, which is validated by experiments for helium.

537.56

8990 THE MOTION OF POSITIVE IONS IN A NATURAL GAS UNDER THE EFFECT OF ELECTRIC AND MAGNETIC FIELDS. Yu.V.Vandakurov and V.I.Perel'.

Zh. tekh. Fiz., Vol. 29, No. 8, 958-61 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 871-4 (Feb., 1960).

The velocity distribution function is obtained for the case in which the mean energy of the ions is much larger than the mean energy of the neutral atoms. It is assumed that the main interaction mechanism between the ions and the atoms is resonance charge exchange.

537.56

8991 THE INFLUENCE OF THE RAMSAUER–TOWNSEND EFFECT UPON ELECTRON MOBILITY IN SPECTRALLY PURE ARGON.

A.A.Vorob'ev, B.A.Ivanov, A.P.Komar and V.A.Korolev.

Zh. tekh. Fiz., Vol. 29, No. 10, 1252-8 (Oct., 1959). In Russian. English translation in Soviet Physics—Technical Physics (New York). Vol. 4, No. 10, 1148-53 (April, 1960).

Electron mobility in spectrally pure argon was measured. The maximum value of the curve showing the dependence of the drift velocity upon ϵ/p occurs for small values of ϵ/p. The presence of the maximum in the given case cannot be explained by the excitation of the energy levels of impurity molecules in the argon. On the other hand, the position and magnitude of the maximum agree with the assumption regarding the influence of the Ramsauer–Townsend effect upon the magnitude of the electron mobility.

537.56

8992 COEFFICIENT OF IONIZATION AND MOBILITY OF ELECTRONS IN ARGON. V.E.Golant.

Zh. tekh. Fiz., Vol. 29, No. 6, 756-8 (Dec., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 680-2 (Dec., 1959).

In an earlier paper (Abstr. 4040 of 1958), the velocity distribution of electrons for a high-frequency discharge in argon was calculated. The zero frequency case is now used to derive the mobility and the Townsend coefficient for a d.c. discharge in argon. The theoretical curve agrees well with the experimental data of Kruithoff and Penning (Abstr. 3809 of 1936). D.Walsh

537.56

8993 ELECTRON MOBILITY IN LIQUID ARGON. F.D.Stacey.

Austral. J. Phys., Vol. 12, No. 1, 105-8 (March, 1959).

It is suggested that the experimental results reported by Williams (see Abstr. 3202 of 1957) can be explained by postulating the formation of negative argon ions with lifetime of the order 3×10^{-11} sec and binding energy about 0.03 eV. J.Hawgood

537.56

8994 MOBILITY OF HYDROGEN AND DEUTERIUM POSITIVE IONS IN THEIR PARENT GASES. D.J.Rose.

J. appl. Phys., Vol. 31, No. 4, 643-5 (April, 1960).

The mobilities of positive ions in H_2 and D_2 have been measured, using a pulsed Townsend technique. For hydrogen, the mobility μ_0 corrected to 0°C was 11.8 ($cm^2V^{-1}sec^{-1}$) at $E/p_0 = 26$ ($Vsec^{-1}mm^{-1}$ Hg), increasing to a maximum of 15.3 at $E/p_0 = 48$, then decreasing to 11.6 at $E/p_0 = 150$. For deuterium, the mobility was about 0.75 the value for hydrogen throughout the range of E/p_0. The experiment was performed with uranium-purified gas in an ultra-high vacuum system. Ions were not identified as atomic, diatomic, or triatomic; there was no conclusive evidence of more than one ion at any value of E/p_0. The H_2 mobility data are significantly lower than those attributed to Mitchell in the range $20 < E/p_0 < 40$, and lower than the value ≅ 12.5 for zero-field mobility generally reported.

537.56

8995 A NEW METHOD FOR MEASURING THE ATTACHMENT OF SLOW ELECTRONS IN GASES.

L.G.H.Huxley, R.W. Crompton and C.H.Bagot.

Austral. J. Phys., Vol. 12, No. 3, 303-8 (Sept., 1959).

The method is based essentially on Townsends' diffusion techniques for the measurement of swarm constants. An analytical treatment is given and results, for attachment coefficients in oxygen for a Z/p range of about 5-20 Vcm^{-1} mm^{-1} Hg, are quoted.

J.D.Craggs

537.56

8996 THE ATTACHMENT OF SLOW ELECTRONS IN CARBON DIOXIDE. J.D.Craggs and B.A.Tozer.

Proc. Roy. Soc. A, Vol. 254, 229-41 (Feb. 9, 1960).

The formation of positive and negative ions in carbon dioxide was investigated by means of a Lozier apparatus. The negative ion process was interpreted as

$$CO_2 + e \rightarrow CO(X\,^1\Sigma^+) + O^-(2P^5).$$

The (peak) cross-section for electron attachment was found to be $5.07 \pm 0.5 \times 10^{-19}$ cm^2 at 7.8 eV, and the ionization cross-section reached a maximum value of 6.80×10^{-16} cm^2 at 85 eV. Measurements of the electron affinity of oxygen by the normal electron impact method yielded a value of 1.6 ± 0.2 eV for O^- ions formed with an initial kinetic energy of 1.8 eV. It is shown that this apparent value of electron affinity must be corrected, because of the initial kinetic energy of the ions and the energy spread of the source electrons, and then yields a value of 1.2 ± 0.3 eV.

537.56

8997 ELECTRON CAPTURE OF THE ACCIDENTAL RESONANCE TYPE. D.R.Bates and N.Lynn.

Proc. Roy. Soc. A, Vol. 253, 141-53 (Nov. 24, 1959).

Consideration is given to the characteristics of electron capture of the accidental resonance type exemplified by

$$He^{2+} + H(1s) \rightarrow He^+(2s \text{ or } 2p) + H^+.$$

In contrast to what happens when the resonance is symmetrical, as in

$$H^+ + H(1s) \rightarrow H(1s) + H^+,$$

the cross-section is small at low velocities of relative motion and tends rapidly towards zero as the velocity is decreased, the behaviour being, in fact, almost adiabatic. This is of interest in several connections: for instance, it is of interest in aeronomy where the processes

$$H^+ + O(^3P) \rightarrow H(1s) + O^+(^4S)$$

and

$$O^+(^2D) + N_2(X\,^1\Sigma_g^+\, v=0) \rightarrow O(^3P) + N_2^+(A\,^2\Pi_u\, v=1)$$

have been assumed by some workers to occur rapidly in thermal encounters simply because the energy balance is almost exact; and again it is of interest in relation to the mobility of a molecular ion in its parent molecular gas.

537.56 : 539.18

8998 ELECTRON CAPTURE BY TRIPLY CHARGED Ne^{3+} AND Kr^{3+} IONS IN NEON AND KRYPTON.

I.P.Flaks and L.G.Filippenko.

Zh. tekh. Fiz., Vol. 29, No. 9, 1100-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 1005-13 (March, 1960).

Electron-capture cross-sections of these ions (energy range 6 to 90 keV) were determined experimentally. Single collisions of triply-charged ions with gas atoms result in the capture of not only one ($I^{3+} \rightarrow I^{2+}$) or two ($I^{3+} \rightarrow I^{+}$) electrons, but also in capture of three electrons ($I^{3+} \rightarrow I^{0}$) from the envelope of the gas atom. The cross-section for the capture of three electrons (σ_{30}) is smaller than the cross-section for one (σ_{31}) or two (σ_{32}) electrons; for ions in their own gas the cross-section σ_{30} reaches 10^{-16} cm^2. The value of σ_{30} increases when the kinetic energy of the ions T_0 decreases, and for $T_0 < 10$-15 keV, σ_{30} is somewhat larger than σ_{31}. For the Ne^{3+}–Kr pair, σ_{30} is of the order of 10^{-17} cm^2; for the Kr^{3+}–Ne pair, σ_{30} is very small and could not be measured. For an ion in its own gas, the values of σ_{30} and σ_{31} are very close to each other; they increase with the energy of the ions. At $T_0 = 90$ keV, $\sigma_{30} = 1.8 \times 10^{-15}$ cm^2, and $\sigma_{31} = 6.5 \times 10^{-16}$ cm^2 for the Kr^{3+}–Kr pair; for the Ne^{3+}–Ne pair, $\sigma_{30} = 4 \times 10^{-6}$ cm^2, and $\sigma_{31} = 1.8 \times 10^{-15}$ cm^2. For ions and atoms corresponding to different elements, the values of σ_{30} and σ_{31} differ by more than one order. The electron-capture cross-sections σ_{30} and σ_{31} of Ne^{3+} in krypton decrease with the energy of the ions. For the Kr^{3+}–Ne pair, σ_{30} and σ_{31} increase with the energy of the ions. It is shown that the cross-section depends on the sign of the energy defect ΔE. For exothermic processes ($\Delta E < 0$) the cross-sections are considerably larger than for endothermic processes ($\Delta E > 0$).

537.56

8999 RESONANCE CHARGE EXCHANGE OF DOUBLY-CHARGED IONS IN SLOW COLLISIONS.
I.K.Fetisov and O.B.Firsov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 95-7 (July, 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 67-8 (Jan., 1960).

The cross-section for resonance charge exchange is computed in the adiabatic approximation. A comparison is made between the experimental and theoretical charge exchange cross-sections for doubly-charged positive A, Kr, Xe and Ne ions.

537.56

9000 RESONANT CHARGE-EXCHANGE AND THE KINETICS OF IONS [IN THEIR OWN GAS].
I.Popescu Iovitsu and N.Ionescu-Pallas [N.Ionesku-Pallas].
Zh. tekh. Fiz., Vol. 29, No. 7, 866-76 (July, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 7, 781-91 (Jan., 1960).

Quantum calculations give a direct dependence of the cross-section of resonant charge-exchange on the relative velocity of the ions and the ionization potential. An expression for ion drift is also given. The relations derived are confirmed by experimental results.

ELECTRIC DISCHARGES

537.52 : 551.5

A THEORY OF BALL LIGHTNING FORMATION.
See Abstr. 8422

537.52

9001 NOISE SPECTRA OF A PROBE IN A HOT-CATHODE DISCHARGE. D.A.Bell.
Proc. Phys. Soc., Vol. 75, Pt 3, 462 (March, 1960).

Briefly discusses noise potentials at a floating probe by comparing a negative probe system with a retarding field diode.

J.D.Craggs

537.52

9002 CONCERNING THE RIGHT BRANCH OF THE FUNCTION $U_f = F(pd)$ FOR INERT GASES. P.N.Chistyakov.
Zh. tekh. Fiz., Vol. 29, No. 10, 1259-62 (Oct., 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 10, 1154-7 (April, 1960).

An investigation was made for a discharge gap with flat electrodes. A precise value was found for the normal cathode fall i.e. the limiting conditions for a clean cathode surface and for a gas were obtained. The cathode material was Ni, and the gases were He and He + 1% A. The form of the function was preserved, but the firing voltage U_f for the corresponding value of pd decreased 10%, on the average, in comparison with previously obtained values.

537.52

9003 PENETRATION DEPTH INVESTIGATION OF GAS CLEANUP WITH RADIOACTIVE TRACERS.
C.Y.Bartholomew and A.R.La Padula.
J. appl. Phys., Vol. 31, No. 2, 445 (Feb., 1960).

Experiments were performed using Kr^{85} as a tracer, in glow discharge tubes with Ni cathodes running at 35 mA, 150 V in Ne–A containing about 0.0001% Kr^{85}. Kr ions penetrated the cathode and the Kr density–depth relation was found using step by step abrasion of the surface. The 50% density depth was about 0.01 mil. J.D.Craggs

537.52 : 621.387

9004 THE ROLE OF SPACE CHARGE IN GAS BREAK-THROUGH BETWEEN EQUAL PARALLEL PLANE ELECTRODES BELOW THE PASCHEN PD MINIMUM. H.Ritow.
J. Electronics and Control, Vol. 7, No. 5, 423-38 (Nov., 1959).

Field-emission theory is used to obtain explanations of the left branch of the Pascben curve, the small-gap discharge and its knee characteristics, the "vacuum" discharge and the V_B versus $\sqrt{D}$ law. A possible explanation of the Paschen minimum P × D is presented. Townsend and "right" side ionization processes are contrasted.

537.52

9005 MASS SPECTROMETER INVESTIGATIONS OF THE CHARGE CARRIERS DIFFUSED AND EXTRACTED FROM THE POSITIVE COLUMN OF OXYGEN GLOW DISCHARGES.
G.Brederlow.
Ann. Phys. (Leipzig), Folge 7, Vol. 5, No.7-8, 414-28 (1960).
In German.

A detailed investigation of the electrons, negative ions (O^- and O_2^-) and positive ions (O_2^+ and O_4^+) issuing from a discharge running at 20-120 mA and about 2.5 mm Hg pressure. Energy distributions are shown. J.D.Craggs

537.52

9006 TRANSFER OF ELECTRODE MATERIAL IN THE PRE-BREAKDOWN PHASE AND IN ELECTRICAL BREAK-DOWN IN HIGH VACUUM. L.V.Tarasova and A.A.Razin.
Zh. tekh. Fiz., Vol. 29, No. 8, 967-74 (Aug., 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 8, 879-85 (Feb., 1960).

A tracer isotope method was used to determine the ratio of the number of transferred copper atoms to the total transferred charge for voltages of 35-100 kV in a two-electrode gap in high vacuum. For an activated anode and an activated cathode in microdischarges, the value of n/q is found to be greater than unity. In order to explain these experimental results, the suggestion is advanced that the effect is due to the growth of metallic points and their detachment from the electrode surface under the effect of constant electric fields of 10^6-10^9 V/cm, and the bombardment of the electrode surface by electrons or ions. This hypothesis furnishes an explanation of the appearance of multi-atom charged metal particles in the interelectrode space in the predischarge phase. When the energies are high enough, these particles are responsible for the transition to electrical breakdown in accordance with a mechanism which explains the electrical breakdown by the detachment of particles from the electrodes.

537.52

9007 INSULATING PARTICLES ON CATHODE SURFACES: THEIR EFFECT UPON ELECTRICAL DISCHARGES.
L.B.Griffiths and P.C.L.Pfeil.
Nature (London), Vol. 184, 1475-6 (Nov. 7, 1959).

A 500 V spark gap was used, and the minimum values of p.d for arcing were found as a function of particle size for various substances (alumina and diamond) placed on the cathode surface. p.d values varied from about 90 to 350 V for different particle sizes.

J.D.Craggs

537.52

9008 FILAMENTARY DISCHARGE EMITTED BY A FINE POINT HELD AT A HIGH POSITIVE POTENTIAL WITH RESPECT TO A PLANE. M.Skowronek.
C.R. Acad. Sci. (Paris), Vol. 250, No. 10, 1808-11 (March 7, 1960).
In French.

Discharges between a positive point and ring or plane electrode are considered. There are two discharge regimes, stable and unstable, and these are shown to be current limited. Using points of radius of curvature less than 1 μ and an h.t. voltage of 7 kV, the transition occurred at about 15 μA. In the stable discharge the channel

is pinched, an effect which is shown photographically and by calculating the total current flow in a number of annular zones about the axis of the discharge. The onset of the stable regime is said to be due to the build up of a large concentration of ions. With the ring electrode, jets of ionized gas three or four centimetres long were formed, using tungsten points as small as 0.3 μ radius.

W.G.Townsend

537.52

9009 PROPERTIES OF THE FILAMENTARY DISCHARGE EMITTED BY A FINE POINT. M.Skowronek.

C.R. Acad. Sci (Paris), Vol. 250, No. 11, 1989-91 (March 14, 1960). In French.

A discussion of the properties of jets of ionized gas emitted by a fine point. (See preceding abstract). The variations in voltage necessary to pass a given current in the discharge is plotted as a function of gas pressure for argon and hydrogen. The controlling factor in jet formation is the current density in the discharge, this being little affected by charges in gas or gas pressure. The discharge channel is limited not by magnetic forces but by a sheath of positive ions. The results quoted contradict the upper limits of current density expected from calculations. W.G.Townsend

537.52 : 539.12

9010 SHORTWAVE RADIATION FROM A VACUUM SPARK. S.V.Lebedev, S.L.Mandel'shtam and G.M.Rodin.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 349-54 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 248-52 (Feb., 1960).

It has been established that a spectroscopic light source — a vacuum "hot" spark — emits soft X-ray radiation (wavelengths shorter than 6A). The radiation intensity remains quite high in the arc stage of the discharge, in which case the potential difference across the electrodes is less than 100 volts. A spectroscopic measurement of the electron temperature (Al VII line) indicates T_e = = 2ω 000°.

537.52

9011 THE DEGREE OF TRANSPARENCY OF A DISCHARGE IN XENON AT VERY HIGH PRESSURES.

R.E.Rovinskii and G.P.Razumtseva.

Optika i Spektrosk., Vol.7, No. 6, 725-8 (Dec., 1959). In Russian.

Dependence of the degree of transparency of a discharge in xenon-filled high-pressure (20-25 atm) lamps on the discharge power per unit length was obtained. From the results obtained and the measured geometrical depth of the discharge a mean value of the absorption coefficient of the discharge column was calculated.

A.Tybulewicz

537.52

9012 THE EFFECT OF INCLUSIONS ON THE ARCING BEHAVIOUR OF METALS. P.C.L.Pfeil and L.B.Griffiths.

J. nuclear Mater., Vol. 1, No. 3, 244-8 (Oct., 1959).

Metallographically prepared specimens of commercial and laboratory-made stainless steel and copper have been made the negative electrode of a small spark gap in a low pressure hydrogen atmosphere, with the ultimate aim of predicting the suitability of these materials as components of thermonuclear apparatus. Microscopical examination, subsequent to sparking in the experimental tube, revealed that surface damage of the specimens had occurred around certain types of inclusion in the metals, the remainder of the surface being unaffected. A correlation has been established between the resistivity of inclusions and their effectiveness as arc-initiators.

537.52

9013 THE MEASUREMENT AND INTERPRETATION OF ARC CHARACTERISTICS (A, N_2). H.Maecker.

Z. Phys., Vol. 158, No. 4, 392-404 (1960). In German.

Gives an analytical summary of energy balance relations, etc., and proceeds to give very detailed characteristics (particularly voltage–current relations) for currents of up to about 300 A. These are related to data for effective radius electrical conductivity, etc. A cascaded-electrode chamber was used. J.D.Craggs

537.52

9014 OPERATING CONDITIONS FOR A HIGH CURRENT GLOW DISCHARGE. W.Weizel and B.Brandt.

Forschungsber. Wirtsch. -Verkehrsmin. Nordrhein-Westfalen, No. 551, 52 pp. (1958). In German.

The maintenance of glow discharges at high currents (tens of amps or more) is discussed generally. The design of suitable cathodes and cathode mountings is treated in detail, and sketches of various assemblies are shown. The effects of diaphragms in the discharge spaces are also discussed. J.D.Craggs

537.52

9015 THE CURRENT DENSITY AT THE CATHODE OF A GLOW DISCHARGE AT HIGH PRESSURES BETWEEN DIAPHRAGMS WITH A SEPERATE ANODE. W.Weizel and Duk Hyun Whang.

Forschungsber. Wirtsch. -Verkehrsmin. Nordrhein-Westfalen, No. 615, 28 pp.(1958). In German.

Describes a tube with segmented cathode, working over a pressure range of 2-8 mm Hg. Very detailed experimental data, e.g. on current–voltage relations are given. J.D.Craggs

537.52

9016 GLOWS IN DIVIDED DISCHARGE CHAMBERS. W.Weizel and W.Ohlendorf.

Forschungber. Witsch.-Verkehrsmin. Nordhein-Westfalen, No. 616, 38 pp. (1958). In German.

A detailed study of glow discharges with special electrode systems, e.g. divided hollow cathodes. Various characteristics (e.g. current-cathode-fall voltage) are given in considerable detail. Currents were ~ a few hundred milliamps and pressures ~ 0.1 - mm Hg (nitrogen). Special attention is paid to electrode design and arrangement. J.D.Craggs

537.52

9017 ON THE GLOW DISCHARGE THROUGH THE VAPORS OF BENZENE, TOLUENE, AND CHLOROBENZENE. M.Nishi and S.Hamamura.

J. Sci. Hiroshima Univ. A, Vol. 23, No. 2, 201-10 (Dec., 1959).

Spectroscopic experiments on the decomposition and synthesis in the glow discharge through the vapours of benzene, toluene, and chlorobenzene were carried out. The discharge spectra depended markedly on the vapour pressure. At a low vapour pressure (~5 mm Hg) the molecular species were probably destroyed perfectly, because the atomic line spectra from hydrogen and the band spectra from C_2, CH and C_6H_6 were observed. In addition to these spectra a HCl^+ band and a Cl_2^+ band were observed for the vapour of chlorobenzene. At higher vapour pressures (10 ~ 20 mm Hg), a continuous band spectrum extending from about 2500 A to about 5400 A was observed, and, with the increase in vapour pressure, an intensity shift of this continuum was noted. During the discharge, crystalline products were synthesized by a condensation reaction. These products from benzene and toluene were identified respectively as diphenyl and dibenzyl by their absorption spectra and by a melting-point analysis of the mixture.

537.52

9018 THE PRESSURE VARIATION OF THE ELECTRON TEMPERATURE IN THE PLASMA OF A POSITIVE COLUMN IN MOLECULAR GAS GLOW DISCHARGES. B.A.Engelke.

Z. Phys., Vol. 158, No. 4, 422-32 (1960). In German.

An analytical paper dealing with, for example, the influence of dissociation processes on the electron temperature in molecular gases. J.D.Craggs

537.52

9019 CHARACTERISTICS OF A HIGH-FREQUENCY MERCURY DISCHARGE IN A CONSTANT MAGNETIC FIELD. E.I.Vavilin, S.D.Vagner and A.M.Drc'man.

Zh. tekh. Fiz., Vol. 29, No. 10, 1263-70 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1158-64 (April, 1960).

The double-probe method was used to investigate the influence of a constant, axial magnetic field upon the electron temperature, charged-particle concentration, wall ion-current density, and tranverse magnetic field, for various external conditions.

537.52 : 621.387

9020 SIMILITUDE AND ANODE MATERIAL EFFECTS IN H_2 AND D_2 DISCHARGES BELOW THE CRITICAL PRESSURE. G.W.McClure.

J. Electronics and Control, Vol. 7, No. 5, 439-47 (Nov., 1959).

The breakdown potentials of H_2 and D_2 gases were determined below the critical pressure in two discharge tubes of similar shape but of different size in order to ascertain whether or not the initial breakdown conditions conform to Paschen's similarity law. With stainless steel anodes and cathodes, both gases conform extremely

well to Paschen's law over a range of pressures yielding starting potentials from 0.3 to 10 kV. With the same cathodes but with anodes of Pb and Al, small deviations from similarity were observed. It is possible that these deviations are not fundamental, but resulted from deposition of anode material on to the cathode. The present results confirm earlier evidence of a strong dependence of breakdown potential on anode material which occurs only at very low pressure.

537.52

9021 THE TEMPORAL VARIATION OF THE CURRENT INCREASE IN THE STATIC BREAKDOWN OF AIR HYDROGEN AND OXYGEN. H.Mielke.

Z. angew. Phys., Vol. 11, No. 11, 409-14 (Nov., 1959). In German.

Refers to earlier work by Kluckow (Abstr. 7062 of 1958) on the theory of build-up in the uniform field d.c. breakdown regime. Oscillographic measurements of the current build-up were made (up to ~100-400μA). Full analytical discussion of the results and comparison with theory is given. The effects of space charge are described, e.g. the effect on the ionization coefficient α.

J.D.Craggs

537.52

9022 THE TEMPORAL DEVELOPMENT OF TOWNSEND DISCHARGES AND THE INFLUENCE OF SPACE CHARGES. W.Köhrmann.

Z. angew. Phys., Vol. 11, No. 11, 414-18 (Nov., 1959). In German.

A theoretical treatment is given, and in which the effect of space charge is included, for the current build-up in static breakdown conditions (Townsend discharge) where a repeated series of avalanches leads to breakdown. Currents for dry air were about 10-12μA, building up in 40-50μsec. Experimental data, obtained using oscillographic techniques, agree well with those calculated from the theory.

J.D.Craggs

PLASMA

537.56 : 525.5

9023 WAKE OF A SATELLITE TRAVERSING THE IONOSPHERE. S.Rand.

Phys. of Fluids, Vol. 3, No. 2, 265-73 (March-April, 1960).

The particle treatment is applied to a study of the structure of the wake behind a charged body moving supersonically through a low-density plasma. For the case of a body whose dimensions are considerably smaller than a Debye length, a solution is obtained which is very similar in structure to the solution obtained by using the linearized fluid dynamics equation. For the case of a disk whose radial dimensions are much larger than a Debye length, two conical regions are found in the wake. At the surface of each of these cones, over thicknesses of the order of a Debye length, the ion and electron densities are increased over their ambient values. Formulae for the electrohydrodynamic drag on a wire, and on a large disk are obtained.

537.56

9024 ON THE FOKKER–PLANCK EQUATION OF A PLASMA. M.Drăganu.

C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2519-20 (April 4, 1960).

Gives the form taken by the Fokker–Planck equation when spherical polar co-ordinates are used in velocity space and azimuthal symmetry is absent. The work is based on formulae due to Rosenbluth, MacDonald and Judd (Abstr. 8462 of 1957).

O.Penrose

537.56

9025 ELECTROSTATIC INSTABILITIES OF A UNIFORM NON-MAXWELLIAN PLASMA. O.Penrose.

Phys. of Fluids, Vol. 3, No. 2, 258-65 (March-April, 1960).

A stability criterion is obtained starting from Vlasov's collision-free kinetic equations. Possible instabilities propagating parallel to an arbitrary unit vector e are related to a function $F(u) = \Sigma_j \omega_j^2 \int d^3v\, g_j(v)\, \delta(e.v - u)$, where $g_j(v)$ is the normalized unperturbed distribution function, and $\omega_j = (4\pi n_j e_j^2/m_j)^{1/2}$ the plasma frequency, for the jth type of particle. By using a method related to the Nyquist criterion, it is shown that plasma oscillations growing exponentially with time are possible if and only if F(u) has a minimum at a value $u = \xi$ such that $\int_{-\infty}^{\infty} du\,(u - \xi)^{-2}[F(u) - F(\xi)] > 0$.

A study of the initial-value problem confirms that the plasma is normally stable if no exponentially growing modes exist; but there is an exceptional class of distribution functions (recognizable by means of an extension of the above criterion) for which linearized stability theory breaks down. The method is applied to several examples, of which the most important is a model of a current-carrying plasma with Maxwell distributions at different temperatures for electrons and ions. The meaning of the mathematical assumptions made is carefully discussed.

537.56

9026 PLASMA TRAPPING IN CUSPED GEOMETRIES. H.Grad.

Phys. Rev. Letters, Vol. 4, No. 5, 222-3 (March 1, 1960).

The problem of trapping plasma in a cusp configuration is considered both for low and high β-systems. For the first case, it is shown that there exists a zone of specified width near the cusp such that particles injected within it will be trapped. For the case of high β-injection, which actually distorts the field arrangement, trapping is likely to be efficient and will be assisted by asymetry of the cusp coils.

A.H.Gabriel

537.56

9027 ACCELERATED SELF-CONSTRICTED ELECTRON STREAMS IN PLASMA. J.G.Linhart.

Proc. Roy. Soc. A, Vol. 249, 318-34 (Jan. 13, 1959).

The mechanism is described of radial oscillations in a neutralized cylindrical electron stream in an accelerating electric field. The analysis is based on the two-fluid model of plasma. Analytical expressions for small amplitude oscillations and numerical solutions for large amplitudes are derived. It is found, when electron-positive ion collisions are taken into account, that for dense streams in low electric fields the radial oscillations (pinch oscillations) can destroy the streaming character of the electron flow and thus prevent its acceleration.

537.56

9028 ON THE ELECTRICAL BEHAVIOR OF AN IDEAL PLASMA. G.Gambirasio.

Phys. of Fluids, Vol. 3, No. 2, 299-302 (March-April, 1960).

The solution of the equation for the current in an ideal plasma, when the electric field, in a direction perpendicular to a constant magnetic field, is abruptly increased from zero to a constant value, is obtained, using Laplace transforms. An exact solution and approximate solutions for some simple cases are obtained and discussed. An expression and the corresponding L.C.R. network are found for the specific impedance of the plasma.

537.56

9029 INVESTIGATION OF A TOROIDAL DISCHARGE IN A STRONG MAGNETIC FIELD.

G.G.Dolgov-Savel'ev, V.S.Mukhovatov, V.S.Strelkov, M.N.Shepelev and N.A.Yavlinskii.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 394-403 (Feb., 1960). In Russian.

The results of investigation of a plasma ring in a toroidal chamber in a strong magnetic field are presented. No macroscopic oscillations were observation the plasma ring under conditions when the Shafranov–Kruskal stability condition was satisfied. Radiation emitted by the plasma in the visible as well as ultraviolet regions of the spectrum was studied. It is shown that in a metallic chamber with a threshold pressure of $1\text{-}2 \times 10^{-5}$ mm Hg most of the radiated energy is caused by impurity ions.

537.56

9030 IONIZATION BY ION IMPACT IN A COLLAPSING CURRENT SHEET. N.J.Phillips.

Proc. Phys. Soc., Vol. 75, Pt 2, 316-17 (Feb., 1960).

Russian results (see Abstr. 5941 of 1958; 9041 of 1960) show that ionization by electron impact must be much slower than supposed in a previous theory (see Abstr. 7091 of 1960), and that charge exchange is the dominant process in the compression of the gas in the collapsing pinch; this conclusion is reinforced by recent cross-section measurements by Fite. (Proceedings of the Uppsala Conference on Ionization Phenomena in Gases, 1959).

R.S.Pease

537.56

9031 RELATIVISTIC TRANSPORT EQUATIONS FOR A PLASMA. I. Yu.L.Klimontovich.

Zh. eksper. teor. Fiz., Vol 37, No. 3(9), 735-44 (Sept., 1959).

In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 524-30 (March, 1960).

A connection is established between the definitions of the probability of a state and the distribution functions given by various authors, based on the transport equation for a charged particle in an external electromagnetic field. A random function which determines the number of particles in a volume element in phase space is introduced. The electromagnetic field strengths, or the numbers of oscillators, are also considered as random functions. The set of equations for these functions serves as the basis for deriving a chain of equations connecting the moments of the random functions or the corresponding distribution functions of different orders. Through an approximation to this chain of equations we obtain a set of relativistic self-consistent equations. Relativistic expressions are given for the dispersion equations for the transverse and longitudinal plasma waves. A variational principle for a relativistic plasma is considered.

537.56

9032 EQUILIBRIUM OF A PLASMA UNDER HELICAL SYMMETRY CONDITIONS. B.B.Kadomtsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1352-4 (Nov., 1959). In Russian.

A simple example of plasma equilibrium in a magnetic field with helical symmetry is presented.

537.56

9033 SOLUTION OF THE KINETIC EQUATION FOR A PLASMA IN A VARIABLE MAGNETIC FIELD. Yu.N.Barabanenkov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 427-9 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 305-6 (Feb., 1960).

The motion of a completely ionized plasma (collisions being neglected) along a narrow magnetic tube of an axially symmetrical magnetic field is considered by means of the kinetic equation. The equation is solved under the assumption of sufficiently slow variation of the magnetic field. Canonical variables are chosen as the independent variables of the distribution function.

537.56

9034 PERFORMANCE OF A HYDROMAGNETIC PLASMA GUN. J.Marshall.
Phys. of Fluids, Vol. 3, No. 1, 134-5 (Jan.-Feb., 1960).

The coaxial gun operates without an auxiliary magnetic field and accelerates several litres of hydrogen plasma to a velocity of $\sim 1.5 \times 10^7$ cm sec^{-1} transfering approximately 40% of the input energy to kinetic energy of the plasma jet. Under certain conditions a plasma free of electrode materials is obtainable. C.G.Morgan

537.56

9035 HYDROMAGNETIC STABILITY OF A STREAMING CYLINDRICAL INCOMPRESSIBLE PLASMA. N.J.Zabusky.
Phys. of Fluids, Vol. 3, No. 2, 278-88 (March-April, 1960).

A dispersion relation is derived and analysed for the case where the equilibrium velocity of an incompressible, nonresistive, cylindrical plasma has a spiral motion along magnetic field lines. The symmetric hydromagnetic equations are used to derive the plasma hydromagnetic pressure. The dispersion relation is found by matching plasma and outer-region hydromagnetic pressures across a sharp-moving interface. The zeros of the dispersion relation are obtained by a sequence of mappings between three complex planes. The presence of flow introduces overstable modes. For m = 0 the time-divergences are removed by flow. For m = 1 the divergences are enhanced by flow such that the growth rates and oscillation frequencies increase linearly with the flow velocity. The smaller is the wavelength of the disturbance in the z direction, the larger are the overstable eigenvalues.

537.56

9036 PLASMA HEATING BY CURRENT-SATURATION. K.A.George.
Nature (London), Vol. 184, 1790 (Dec. 5, 1959).

States that the process which produces run-away ions in toroidal discharges might be exploited to increase the energy density of the plasma. R.S.Pease

537.56

9037 ANODE REGION IN A LOW-PRESSURE GAS DISCHARGE. II. ROLE OF PLASMA ELECTRON TEMPERATURE, ANODE SURFACE TEMPERATURE, AND ANODE MOLECULAR ACCOMMODATION COEFFICIENT. N.A.Neretina and B.N.Klyarfel'd.
Zh. tekh. Fiz., Vol. 29, No. 1, 15-23 (Jan., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 13-20 (Jan., 1959).

For Pt I, see Abstr. 1500 (1959). Concerned with: (a) the role of the plasma electron temperature of the plasma in front of the anode; (b) the temperature of the anode surface; (c) the accommodation coefficient of the anode surface for the gas molecules. The number of ionization events in the gas can be reduced by lowering the ionization capabilities of the electron gas by removal of the faster electrons by an auxiliary, large-surface, electrode located near the anode; this leads to a reduction in the concentration of positive ions. Under these conditions, the negative space charge associated with the electrons which carry the discharge current to the anode cannot be compensated and this space charge becomes negative. Heating a plane anode, thereby reducing the local density of the gas in front of the anode and the ionization, also produces a positive anode fall (AF). Cooling the anode leads to the appearance of a negative AF. Of the various surface properties of the anode, it is found that the most important, as far as the AF is concerned, is the accommodation coefficient for the gas molecules. As the accommodation coefficient increases, the gas in front of the heated anode becomes more rarefied and the positive AF increases.

537.56

9038 THEORY OF THE STAGNATION-POINT LANGMUIR PROBE. L.Talbot.
Phys. of Fluids, Vol. 3, No. 2, 289-98 (March-April, 1960).

A theory is developed for a Langmuir-type probe consisting of a collecting electrode placed at the stagnation point of a blunt body immersed in a supersonic partially ionized stream. It is shown that under certain conditions, the stagnation-point boundary layer equations and the probe sheath equations can be solved together to yield potential v. current relations which permit the free stream ion and electron densities and temperatures to be measured by such a probe. It is shown also that the stagnation-point heat transfer will vary with probe potential, thus providing additional information useful in plasma jet diagnostics.

537.56

9039 THE OPERATION OF LANGMUIR PROBES IN ELECTRO-NEGATIVE PLASMAS. R.L.F.Boyd and J.B.Thompson.
Proc. Roy. Soc. A, Vol. 252, 102-19 (July 7, 1959).

A criterion that must be satisfied by the positive-ion energy distribution at the edge of a sheath surrounding a negative probe is derived for the case when negative ions are present. This criterion is then used to derive the potential outside the sheath region surrounding a spherical probe immersed in an electro-negative plasma. It is found that the potential falls to low values when the ratio of negative ions to electrons exceeds 2. Under these circumstances the positive-ion current collected is the random current across the sheath edge. If, however, the ratio is much less than 2 then the collection of positive ions proceeds as for an electro-positive gas.

537.56

9040 EFFICIENCY OF THE PLASMA THERMOCOUPLE. H.W.Lewis and J.R.Reitz.
J. appl. Phys., Vol. 31, No. 4, 723-7 (April, 1960).

The efficiency of a thermionic converter containing cesium ions is calculated for the regime, in which the plasma density is sufficiently high so that the random current density, $ne\bar{v}/4$, is large compared to the actual current density. Under these circumstances, positive space charge barriers are set up at the electrodes, and the plasma region is many free paths in length. The output voltage V is determined for various currents by a consistent solution of the electrical and thermal conduction problems. The efficiency of the thermocouple is then deduced from the calculated current-voltage characteristic and the appropriate electron temperature distribution. Overall efficiencies up to 32% are predicted for a typical thermocouple circuit.

537.56 : 77

9041 INVESTIGATION OF PULSED HIGH CURRENT GAS DISCHARGES BY HIGH SPEED PHOTOGRAPHY. N.A.Borzunov, D.V.Orlinsky and S.M.Osovets.

J. nuclear Energy, Vol. 9, No. 1-4, 135-9 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 149 (1958).

High speed (10^6 frames/sec) photographic data on pulsed high energy gas discharges in deuterium and some of the inert gases have been combined with oscillograms of current and voltage to give a qualitative description of the basic processes occurring in the initial stages of a high current discharge. The experimental results confirm the basic conclusions of the inertial theory of plasma constriction worked out by Leontovich and Osovets. (Abstr. 5302 of 1960).

537.56 : 523.877

9042 THE ELECTRON TEMPERATURE OF A MEDIUM SUBJECT TO SYNCHROTRON RADIATION.

G.A.Gurzadyan.

Dokl. Akad. Nauk SSR, Vol. 130, No. 2, 287-90 (Jan. 11, 1960). In Russian.

Using stated assumptions, a relation is obtained for the electron temperature T_e, in terms of γ, a parameter determined by the energy spectrum of the relativistic electrons: $N_e = KE^{-\gamma}$. If $\gamma = 3$, $T_e = 110\,000^\circ$; if $\gamma = 5$, $T_e = 100\,000^\circ$. Experimental verification might be found in the spectra of certain variable stars. G.A.Chisnall

537.56 : 536.55

ELECTRON TEMPERATURE IN HIGH-TEMPERATURE PLASMAS. See Abstr. 8857

537.56

9043 ULTIMATE AND SECONDARY ELECTRON ENERGIES IN THE NEGATIVE GLOW OF A COLD-CATHODE DISCHARGE IN HELIUM. J.M.Anderson.

J. appl. Phys., Vol. 31, No. 3, 511-15 (March, 1960).

The "ultimate" electron density in the negative glow plasma of a cold-cathode discharge in helium at gas pressures 3-12 mm Hg has been determined by simultaneous Langmuir probe and microwave transmission methods. A correlation is obtained at densities above $\sim 4 \times 10^{11}/cm^3$ when the influence of positive ion scattering of the electrons diffusing to the probe is considered. The ultimate electron temperature in the helium negative glow was measured by the metallic probe to be quite low, $\sim 400^\circ$ K, and the "secondary" electron temperature was found to be $\sim 50\,000^\circ$ K. These probe indications are substantiated by measurement of the microwave noise power radiated from the plasma which is found to correspond to an effective temperature varying from 300 to $\sim 1000^\circ$ K.

537.56

9044 EFFECT OF INELASTIC COLLISIONS ON THE VELOCITY DISTRIBUTION OF ELECTRONS.

L.M.Kovrizhnykh.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 490-500 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 347-53 (Feb., 1960).

The velocity distribution function for electrons in a weakly ionized plasma was found, taking into account inelastic collisions. It is shown that the inelastic collisions lead to a sharp drop in the distribution function for electron energies exceeding the excitation (or ionization) energy.

537.56

9045 VELOCITY DISTRIBUTION OF ELECTRONS IN A STRONG ELECTRIC FIELD. L.M.Kovrizhnykh.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1394-400 (Nov., 1959). In Russian.

A method is developed for determination of a nonstationary solution of the Boltzmann equation in the case of strong electric fields. An expression is derived for the electron distribution function in a completely ionized plasma located in a strong electric field. It is shown that in a first approximation the distribution is Maxwellian, superimposed on the general translational motion of the electron gas. In a first approximation the translational velocity increases linearly with time whereas the temperature remains constant.

537.56

9046 KINETIC EQUATIONS FOR PLASMA AND RADIATION. A.Simon and E.G.Harris.

Phys. of Fluids, Vol. 3, No. 2, 245-54 (March-April, 1960).

The starting point is the Liouville equation for the density in phase space of a system of charged particles and a denumerably infinite set of field oscillators. By integrating out the coordinates of all but a finite number of particles and oscillators one obtains a chain of equations relating the reduced distribution functions. A complete solution to the chain is obtained by a generalization of the expansion method of Rosenbluth and Rostoker. In lowest order, a coupled set of selfconsistent field equations in the one-particle and one-oscillator distributions is obtained. These are partially decoupled to give the usual Vlasov equation and a companion equation for the oscillator distribution. In first order one obtains a similar set of equations for the two-particle and the particle-oscillator correlation functions. An entirely similar pair of equations then relates the first-order distribution functions themselves. It appears that the general solution is obtained by the steady unfolding of higher correlation functions in terms of higher and higher selfconsistent field equations. The first order equations can be regarded as a "Fokker-Planck" equation for particles and a "Fokker-Planck" equation for radiation.

537.56

9047 COHERENT AND INCOHERENT RADIATION FROM A PLASMA. E.G.Harris and A.Simon.

Phys. of Fluids, Vol. 3, No. 2, 255-8 (March-April, 1960).

The Vlasov equations have been derived previously by starting from the Liouville equation and treating both plasma particles and electromagnetic field statistically. A byproduct of this derivation was an equation for $f^\lambda(q\lambda,p\lambda)$, the probability density in the phase space of one of the radiation field oscillators. These functions are now used to define an entropy for the electromagnetic field. If the phases and amplitudes of all electromagnetic waves are precisely defined (coherent radiation), the field entropy is negatively infinite. Any incoherence increases the entropy. A direct consequence of the f^λ equation is that the field entropy is a constant of the motion. This is analogous to Newcomb's proof that the particle entropy is constant. It follows that incoherent radiation cannot be calculated from the Vlasov equations.

537.56

9048 LINEARIZED THEORY OF PLASMA OSCILLATIONS. L.Oster.

Rev. mod. Phys., Vol. 32, No. 1, 141-68 (Jan., 1960).

A study of longitudinal and transverse plane waves in a plasma in a zero or uniform magnetic field, first by a hydrodynamic method, and afterwards by an essentially equivalent kinetic method based on the assumption that the perturbed velocity distribution function is locally Maxwellian. There are 28 references. O.Penrose

537.56

9049 ION OSCILLATIONS IN A PLASMA. T.F.Volkov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 422-6 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 302-4 (Feb., 1960).

The effect of a high-frequency electromagnetic field on ion oscillations is considered. It is shown that the frequencies of the quasi-acoustic longitudinal plasma oscillations are functions of the field amplitude. Possible instability mechanisms are discussed.

537.56

9050 PLASMA OSCILLATIONS OF A LARGE NUMBER OF ELECTRON BEAMS. J.M.Dawson.

Phys. Rev., Vol. 118, No. 2, 381-9 (April 15, 1960).

Longitudinal oscillations of a large number of electron beams are investigated. The normal modes for the beams are found. An orthogonality relation between the modes is obtained and is used to solve the initial value problem and the problem of forced oscillations. It is demonstrated that no signal propagates faster than the fastest beam. The problem of passing to the limit of a continuous velocity distribution is considered in detail. It is shown that in the limit the results of Landau, Van Kampen, and others are recovered. The problem of Landau damping is discussed from the point of view of the beams.

537.56

9051 NONLINEAR LANGMUIR ELECTRON OSCILLATIONS IN A PLASMA. M.V.Konyukov.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 799-801 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 570-1 (March, 1960).

An exact solution has been obtained for the nonlinear oscillations of the electron density in a plasma at zero electron temperature. The inital conditions necessary for these oscillations are determined.

537.56 : 551.5

9052 DOPPLER EFFECT IN AN ELECTRON PLASMA IN A MAGNETIC FIELD. K.A.Barsukov and A.A.Kolomenskii.
Zh. tekh. Fiz., Vol. 29, No. 8, 954-7 (Aug., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 868-70 (Feb., 1960).

The complex Doppler effect produced in the motion of an oscillator in an anisotropic plasma is analysed. The ionospheric Doppler effect is given as a numerical example.

537.56

9053 THEORY OF LONGITUDINAL OSCILLATIONS IN AN ELECTRON–ION BEAM. R.V.Polovin and N.L.Tsintsadze.
Zh. tekh. Fiz., Vol. 29, No. 7, 831-2 (July, 1959). In Russian.
English translation in : Soviet Physics – Technical Physics (New York), Vol. 4, No. 7, 751-2 (Jan., 1960).

Considers perturbations of the form exp $[i(\omega t - \mu\phi - jz)]$ in cylindrical coordinates. Uses results of an earlier paper (Abstr. 1088 of 1958) in which $\mu = o$ was assumed, to obtain the conditions of instability. These turn out to be identical with those of the double-stream tube. B.Meltzer

537.56

9054 STABILITY OF LARGE AMPLITUDE WAVES IN THE ONE-DIMENSIONAL PLASMA. D.Montgomery.
Phys. of Fluids, Vol. 3, No. 2, 274-77 (March-April, 1960).

The problem of the stability of the nonlinear plasma oscillations of Bernstein, Greene, and Kruskal (Abstr. 6073 of 1958) is discussed. The eigenvalue equation for the perturbed distribution function possesses an expansion in powers of a parameter proportional to the maximum value of the equilibrium electrostatic potential. The stability of any given distribution can be inferred from consideration of the zeroth order alone.

537.56

9055 ELECTROMAGNETIC WAVES IN A PLASMA SITUATED IN A MAGNETIC FIELD.
Ya.B.Fainberg and M.F.Gorbatenko.
Zh. tekh. Fiz., Vol. 29, No. 5, 549-62 (May, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 487-500 (Nov., 1959).

Investigates the propagation of slow electromagnetic waves in a plasma rod which is situated in an external, unvarying, homogeneous magnetic field, and is isolated from the continuing metallic walls. The scattering equation is obtained which determines the form of the electromagnetic fields, and numerical results are given.

537.56

9056 OSCILLATIONS OF AN INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. L.I.Rudakov and R.Z.Sagdeev.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1337-41 (Nov., 1959).
In Russian.

Small oscillations of a hot plasma confined by the pressure of a magnetic field are treated with aid of the kinetic equation in the "drift" approximation without the collision integral. Two types of waves can exist for the wave vector lying in a plane perpendicular to the direction of the unperturbed magnetic field. One of these is a slow (drift) wave with a propagation velocity of the order of the mean electron (ion) drift velocity in the unperturbed state and the other is a magneto-acoustic wave. The first type of wave is characteristic only of an inhomogeneous plasma. For a certain interdependence between the zero magnetic field gradients, plasma density and plasma temperature the drift current in the unperturbed plasma may lead to amplification of such oscillations. The criteria for instability of this type are obtained.

537.56 : 538.3

PLASMA OSCILLATIONS IN AXIAL MAGNETIC FIELDS.
See Abstr. 7211

537.56 : 538.56

9057 THE REFLECTION OF AN ELECTROMAGNETIC WAVE FROM A PLASMA MOVING THROUGH A DIELECTRIC IN A CONSTANT MAGNETIC FIELD.
Ya.B.Fainberg and V.S.Tkalich.
Zh. tekh. Fiz., Vol. 29, No. 4, 491-6 (April, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 4, 438-43 (April, 1959).

Deduces expressions for the reflection coefficient and frequency change of steady plane waves by an electron plasma moving through a non-dispersive dielectric medium, in the presence of a magnetic field. A significant part of the energy can be reflected from very small plasma densities in certain cases. R.S.Pease

537.56

9058 NON-RESONANT ABSORPTION OF ELECTROMAGNETIC WAVES IN A MAGNETO-ACTIVE PLASMA.
B.N.Gershman.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 695-704 (Sept., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 497-503 (March, 1960).

The absorption (attenuation) outside the gyromagnetic resonance regions is analysed from the general equation for three types of high-frequency wave. Both collisions and the specific plasma-absorption mechanisms are taken into account.

ELECTRON EMISSION
ELECTRON BEAMS

537.533

9059 THE EFFECT OF ADSORBED OXYGEN ON THE WORK FUNCTION OF GERMANIUM.
R.Kh.Burshtein and L.A.Larin.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 3, 565-8 (Jan. 21, 1960).
In Russian.

The work function, φ, of Ge increased linearly with the logarithm of pressure at which oxygen was adsorbed on its surface. On heating in vacuum, φ of specimens with an adsorbed oxygen layer decreased; heating in oxygen at approx. 6 mm Hg pressure brought about an increase in φ. The former effect was attributed to the reaction $GeO_2 + Ge \rightarrow 2GeO$, the latter to the increase in the thickness of the GeO_2 layer. It was concluded that the continuous change of φ of Ge in the presence of several surface oxide layers is probably caused by Ge diffusing through the oxide layer. M.H.Sloboda

537.533

9060 PHOTOELECTRIC DETERMINATION OF THE ELECTRON WORK FUNCTION OF INDIUM.
J.van Laar and J.J.Scheer.
Philips Res. Rep., Vol. 15, No. 1, 1-6 (Feb., 1960).

The photoelectric work function of evaporated indium films prepared in ultra-high vacuum is found to be 4.08 ± 0.01 eV.

537.533

9061 THE TEMPERATURE DEPENDENCE OF THE WORK FUNCTION OF MOLYBDENUM. B.Iosifescu.
Rev. de Physique (Bucarest), Vol. 4, No. 3, 345-54 (1959).
In Russian.

It is claimed that by using the method of displacement of the current–voltage characteristics and by conducting the experiments in high vacuum of $\sim 4.10^{-9}$ mm Hg, accuracy of 10^{-3} eV was attained in determining the work function, ψ, of Mo. The temperature coefficient of ψ in the 600-1100°K range was found to be $(7.9 \pm 0.07) \times \times 10^{-5}$ eV per deg C. M.H.Sloboda

537.533

9062 CHANGE OF WORK FUNCTION OF MOLYBDENUM BY DEPOSITION OF THIN LAYERS OF SODIUM AND CAESIUM. V.N.Lepeshinskaya and V.N.Belogurov.
Fiz. tverdogo Tela, Vol. 1, No. 12, 1806-12 (Dec., 1959). In Russian.

It is known that the deposition of thin layers of alkali metals on an electron emitter lowers its work function, but there have been doubts as to the effect of deposits less than a monolayer thick. It is now found that caesium deposited in tenth-monolayer steps at first rapidly lowers the work function of molybdenum, but that some of the improvement is lost as the deposit thickens; while the deposition of sodium at first raises the work function and only starts driving it down when the thickness reaches one monolayer. The measuring apparatus needs special design so as to operate quickly, before the measurements can be spoilt by the arrival of residual gas atoms. A.E.I. Research Laboratory

537.533

9063 ON THE TEMPERATURE DEPENDENCE OF THE WORK FUNCTION OF NICKEL. G.Comşa.
Rev. de Physique (Bucarest), Vol. 4, No. 3, 337-44 (1959). In German.

Analysis of the results of several authors on the work function of nickel. The value decreases linearly with increasing temperature but the slopes are different on either side of the anomaly which is observed at the Curie point. C.A.Hogarth

537.533 : 541.18

9064 ELECTRONIC AND ADSORPTION PROPERTIES OF AN ATOMIC BARIUM FILM ON THE SURFACE OF OXYGEN-COATED TUNGSTEN.

Yu.S.Vedula, V.M.Gavrilyuk and N.D.Morgulis.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1717-19 (Nov., 1959). In Russian.

The method used [see Vedula and Gavrilyuk, Ukrayin. fiz. Zh., Vol. 3, 632 (1958); Morgulis, Ptushinskii and Naumovets, Zh. tekh. Fiz. (in press)] consisted in determining variation of the work function of an electron by means of contact potential, the usual W ribbon (φ_0 = 4.5 eV) being coated with Ba and O films whose purity was tested with a mass spectrometer. It was found that even a small preliminary coating of W with O has a very substantial and favourable effect, i.e. it reduces somewhat the value of φ and markedly raises the adsorption stability (energy of adsorption) of the film. From $\varphi_k \cong 5.5$ eV (about 1400-1500° K) the isobars of the Ba–O–W system become very irregular. F.Lachman

537.533 : 539.2 : 535.37

9065 EXCITATION OF PHOTOSTIMULATED CO-EXO-ELECTRON EMISSION BY ANODIC OXIDATION OF ALUMINIUM. T.Lewowski.

Z.Naturforsch, Vol. 15a, No. 1, 90-1 (Jan., 1960). In German.

An attempt is made to determine whether exo-electron emission is associated with the electroluminescence during anodic oxidation. Direct and alternating currents were used in electrolysis and luminescence observed at the anode. After washing and cold drying, stimulation of exo-electron emission was obtained after a.c. electrolysis but not after d.c. electrolysis. G.F.J.Garlick

537.533

9066 THE CURRENT-VOLTAGE CHARACTERISTICS OF THE AUTO-ELECTRON ["HOT" ELECTRON] CURRENT FROM SEMICONDUCTORS.

Yu.V.Zubenko, A.I.Klimin and I.L.Sokol'skaya.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1845-7 (Dec., 1959). In Russian.

Stratton's theory of the emission of "hot" electrons from semiconductors predicts a non-linear relationship between the logarithm of the current and the reciprocal of the applied voltage. Experiments with germanium and tungsten carbide, however, reveal a reproducible linear relationship. The significance of this is discussed. A.E.I. Research Laboratory

537.533 : 621.385.032.212

9067 STABLE, HIGH DENSITY FIELD EMISSION COLD CATHODE. E.E.Martin, J.K.Trolan and W.P.Dyke.

J. appl. Phys., Vol. 31, No. 5, 782-9 (May, 1960).

The practical application of the field emission electron source has heretofore been impeded by insufficient reliability. Instability (i.e. changes in emitted current at a fixed applied voltage) results from changes in the cold cathode surface associated with contamination and sputtering. The cold clean cathode is shown the be electrically stable at d.c. emission densities up to 10^7 A/cm^2. Techniques are discussed which permitted stable operation of a single needle tungsten cathode during 1000 hr at an average beam power of 35 W (corresponding to a beam power density of 35×10^9 W per unit cathode area). A simple method is described which permits reconditioning of the cathode surface when required, and apparently extends life indefinitely; operating periods in excess of 12 000 hr are reported. An explanation is suggested for the small, gradual residual changes observed in the emitted current.

537.533 : 621.385.032.213

9068 ELECTRICAL STABILITY AND LIFE OF THE HEATED FIELD EMISSION CATHODE.

W.P.Dyke, F.M.Charbonnier, R.W.Strayer, R.L.Floyd, J.P.Barbour and J.K.Trolan.

J. appl. Phys., Vol. 31, No.5, 790-805 (May, 1960).

The cold tungsten field cathode exhibits electrical stability and long life (12 000 hr demonstrated) at d.c. emission densities up to 10^7/cm^2, when operated in vacuum tubes with a residual gas pressure below 10^{-12} mm Hg; with a provision for periodic reconditioning of the cathode surface by a brief flash heating, satisfactory operation of the cold cathode may be achieved at tube pressures up to about 10^{-9}mm Hg. Continuous heating of the field cathode is shown to yield useful electrical stability at conventional tube pressure, e.g. 10^{-6}mm Hg. The theory of transport phenomena in heated metals is applied to a quantitative study of the geometrical stability of the heated field cathode. Expressions are derived for the time rate of change of cathode tip radius in the presence or absence of d.c. and pulsed electric fields at the cathode surface, and long-term geometrical stability of the cathode surface is predicted when the average applied field has the proper value. Large cathodes operated at high current level will only tolerate pulsed emission, and expressions are obtained for the maximum allowed duty cycle and pulse length in this case; small heated cathodes are capable of stable d.c.emission. Occurrence of a vacuum arc is proposed as the cause of cathode failure. Considerations based on this assumption lead to predictions concerning the dependence of average cathode life on temperature, and to quantitative expressions for the statistical distribution and average value of life for unbiased field cathodes operated at high temperatures. Experimental results yielded by the operation of 85 cathodes show good agreement with the theory. The heated cathode shows constant performance over a long period after which cathode failure occurs abruptly, and the statistical nature of cathode life is confirmed. The statistical distribution of cathode life and the measured effect of various parameters on average life show good agreement with theoretical predictions. Unbiased tungsten cathodes yielded an average life of 250 hr at an optimum cathode temperature of 2040° K. With the application of a suitable bias both long-term stability and an average life of 487 hr at 1970° K have been achieved, and according to the theory a substantial further increase in average life may be obtained by the use of a higher cathode temperature and of cathode materials with reduced impurity content.

537.533 : 621.385.032.213.13

9069 ENERGY DISTRIBUTION AND COOLING EFFECT OF ELECTRONS EMITTED FROM AN ARC CATHODE.

T.H.Lee.

J. appl. Phys., Vol. 31, No. 5, 924-7 (May, 1960).

The energy distribution and the average cooling effect of electrons emitted by the T–F process are calculated over a wide range of temperatures and electric fields for several values of work functions. It is shown that at low temperatures, the average cooling effect approaches zero and at high temperatures, it is approximately equal to the reduced work function. The limitation of the validity of reduced work function can be easily seen.

537.533

9070 LONG TIME-CONSTANT DECAY EFFECT OF OXIDE-COATED CATHODES. L.Ernst.

Acta phys. Hungar., Vol. 7, No. 4, 473-6 (1957).

Reports measurements of an observed increase in diode resistance during periods of several minutes after switching on. The effect is larger and lasts longer for lower temperatures. Measurements of the interface resistance showed that the whole effect was due to the cathode. The observed times are consistent with Ba diffusion times, away from the interface. A.H.W.Beck

537.533 : 621.385.1

9071 CHARGE LOCALIZATION ON THE SURFACES OF OXIDE-COATED CATHODES.

B.J.Hopkins and F.A.Vick.

Brit. J. appl. Phys., Vol. 11, No. 6, 223-7 (June, 1960).

Anomalous results obtained while using the Kelvin method of determining contact potential differences between oxide-coated cathodes and an evaporated gold film reference surface in an atmosphere of hydrogen have been investigated. Very high contact potential differences have been associated with a separation of charge from ionized gas on the passage of a discharge current. This charge, either positive ions or electrons, remains on the surface of the oxide cathode for periods (sometimes as long as several days) dependent on the conductivity of the oxide coating. This in turn depends upon the nature of the oxide material, its state of activation and its temperature. Experiments are also described on the behaviour of probe cathodes in hydrogen.

537.533 : 621.385.032.213.13

9072 THE POISONING OF IMPREGNATED CATHODES. R.O.Jenkins and W.G Trodden.

J. Electronics and Control, Vol. 7, No. 5, 393-415 (Nov., 1959).

The poisoning of barium–calcium aluminate impregnated tungsten cathodes by various gases was investigated experimentally. It is shown that oxygen, water vapour, carbon dioxide and air poison these cathodes, while carbon monoxide, nitrogen and hydrogen do

not. Poisoning takes place with the former gases if a critical pressure, depending on the gas is exceeded, this pressure increasing with cathode temperature. For a normal operating temperature of 1100°C the approximate critical pressures for the gases are as follows: O_2 10^{-7} mm, H_2O 3×10^{-7} mm, CO_2 10^{-6} mm and air 5×10^{-6} mm. Cathodes with two different porosites of tungsten show somewhat different poisoning characteristics. The amount of poisoning increases rapidly with the pressure when once the critical pressure p_0 is exceeded, an equilibrium value of the emission poisoning ratio dependent on p/p_0 being reached. For very severe poisoning, the reactivation time increases with the time the cathode has been held in the poisoned condition, but for small degrees of poisoning the recovery rate depends only on cathode temperature. A theory correlating the various observations is proposed, based on the probabilities of gas adsorption, and rates of barium production, evaporation and migration.

537.533

9073 INFRARED PHOTOEMISSION. G.A.Morton.

Proc. Inst. Radio Engrs, Vol. 47, No. 9, 1467-9 (Sept., 1959).

The preparation and properties of silver–oxygen–caesium photocathodes are described. C.Hilsum

537.533

9074 PHOTOEFFECT IN THIN METAL FILMS. F.Baumann.

Z. Phys., Vol. 158, No. 5, 607-22 (1960). In German.

The photoelectric emission of thin metal layers produced by quenching condensation at low temperatures is measured immediately after condensation and after different annealing processes. The investigated metals are Pb, Sn, Bi and Sn + 10 at. % Cu. During annealing two effects are observed. The photoelectric sensitivity is lowered and the threshold is shifted by several mμ. The energy dependence of the photoelectric sensitivity in layers of Pb and pure Sn can be described in the whole region by Fowler's theory. The sensitivity decrease during annealing is discussed in terms of the precipitation of lattice defects and can be compared with the infrared absorption measurements on these layers by Hasse (Abstr. 4391 of 1960).

537.533 : 539.2 : 535.33

9075 EXO-ELECTRON EMISSION AND THE OPTICAL PROPERTIES OF OXIDE-COATED METAL SURFACES. J.A.Ramsey.

Nature (London), Vol. 185, 602 (Feb. 27, 1960).

The optical constants of mechanically polished Al and Zn surfaces have been determined over the range 450–650 mμ by the Drude method. At about 470 mμ, the absorption index k shows an increase and the refractive index n a decrease. It is suggested that there may be a relation between these changes in n and k and the strong exo-electron emission from abraded Al, Zn and Mg irradiated with light of wavelength 470 mμ reported by Grunberg and Wright (Abstr. 3305 of 1956). C.H.B.Mee

537.533

9076 DISCRETE ELECTRON ENERGY LOSSES AND SECONDARY EMISSION FROM CdO. N.B Gornyi.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 340-8 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 242-7 (Feb., 1959).

It is shown that the discrete energy losses of the electrons reflected from a CdO surface are determined by the CdO crystal structure. The spectra of the discrete losses in CdO and MgO, which have identical crystal lattices (face-centred cubic), are similar and their differences are due to differences in the lattice constants. The groups of genuine secondary electrons with discrete energies are produced in CdO by a single mechanism, which produces these discrete electron energy losses. The maximum value of the secondary electron emission coefficient (δ max) for CdO is 1.25. The small magnitude of this quantity confirms an earlier suggestion regarding the dependence of δ_{max} on the relation between the minimum discrete energy loss and the electron work function.

537.533

9077 ON SECONDARY ELECTRON EMISSION AND ELASTIC REFLECTION OF SLOW ELECTRONS FROM MONOCRYSTALLINE NaCl. S.A.Fridrikhov.

Fiz. tverdogo Tela, Vol. 2, No. 1, 171-3 (Jan., 1960). In Russian.

The secondary electrons emitted from monocrystalline sodium chloride mounted on a tantalum target and bombarded by electrons of energies up to 50 eV are recorded automatically. It is shown how the total can be split into parts depending on elastic scattering and inelastic scattering plus genuine secondary emission respectively. A.E.I. Research Laboratory

537.533 : 537.534

9078 THE EMISSION OF CHARGED PARTICLES FROM THE SURFACES OF METALS BOMBARDED WITH POSITIVE IONS. Ya.M.Fogel', R.P.Slabospitskii and A.B.Rastrepin.

Zh. tekh. Fiz., Vol. 30, No. 1, 63-73 (Jan., 1960). In Russian.

Describes a method for the simultaneous measurement of secondary-emission coefficients of positive ions, negative ions and electrons, together with the reflection coefficient of primary bombarding ions, for conducting targets exposed to positive-ion bombardment. Details of the experimental apparatus are given, and the results of measurements on Mo, Ta, W, Cu and Fe targets, bombarded by H^+, Ne^+ and A^+ ions, are described; the primary energies were in the range 10 to 40 keV. Measurements are also given for targets of Mo bombarded by He^+, Kr^+ and O^+ ions, and the secondary-emission and reflection coefficients are compared for bombardment of Mo targets by negative and positive hydrogen ions. The effect of surface-adsorbed gas in the metal targets is discussed, and experiments are described which demonstrate the effect of adsorbed hydrogen on the measured coefficients. V.V.Zakharov

537.533 : 621.385.6

9079 SOME SOLUTIONS TO THE EQUATIONS OF STEADY SPACE CHARGE FLOW IN MAGNETIC FIELDS. P.T.Kirstein.

J. Electronics and Control, Vol. 7, No. 5, 417-22 (Nov., 1959).

The equations for steady, laminar space-charge flow are set up. Sets of particular solutions in prescribed magnetic fields are presented — even when the magnetic field has components perpendicular to the cathode. Flows in a large class of magnetic fields from cylindrical and conical cathodes are shown to result, and the existence of similar flows from spiral-sheet cathodes are mentioned.

537.533

9080 SOLUTIONS OF THE EQUATIONS OF SPACE CHARGE FLOW FOR RADIAL FLOW BETWEEN CONCENTRIC SPHERICAL ELECTRODES. I.Rzkan.

J. appl. Phys., Vol. 31, No. 4, 652-5 (April, 1960).

The solutions of the equations of space charge flow of electron beams for radial flow between concentric spherical electrodes are formulated in such a manner as to permit the introduction of arbitrary initial conditions. This allows one to solve a variety of physical problems with the aid of a table of Airy functions. A particular case, which exhibits a potential minimum between electrodes, is presented as an illustrative example.

537.533 : 621.385.64

9081 INSTABILITY OF THE ELECTRON CLOUD IN A MAGNETRON. B.B.Kadomtsev.

Zh. tekh. Fiz., Vol. 29, No. 7, 833-44 (July, 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 7, 753-63 (Jan., 1960).

It is shown that in a field H, which is larger than the critical field, the stationary electron cloud in a smooth magnetron (in which the electrons move in loops) is unstable, and that the time for small perturbations to build up in the stationary state is of the same order of magnitude as the electron time of flight.

537.533

9082 COMMENTS ON ARTICLE BY COOK. M.H.Miller.

J. appl. Phys., Vol. 31, No. 3, 607-8 (March, 1960).

Recent treatment (Abstr. 8216 of 1959) of the behaviour of long dense electron beams is shown to be a particular case of a more general theorem. The general treatment is developed and applied to the classification of various types of electron flow. A.E.I.Research Laboratory

537.533

9083 DETERMINATION OF A RELATIVISTIC ELECTRON BEAM. N.L.Tsintsadze.

Zh. tekh. Fiz., Vol. 29, No. 1, 24-6 (Jan., 1959). In Russian. English translation in : Soviet Physics — Technical Physics (New York), Vol. 4, No. 1, 21-3 (Jan., 1959).

Analyses motion of axially-symmetric, thin electron beam in

the presence of positive ions, nett charge density being small compared with electron charge density, the motion being assumed adiabatic, and the self-magnetic field taken into account. A perturbation calculation of the beam shape yields a complicated integral expression, which for the case of very small deviations gives a sinusoidally modulated profile. B.Meltzer

537.533

9084 EQUILIBRIUM CONDITIONS FOR ELECTRON BEAMS. V.S.Anastasevich.
Zh. tekh. Fiz., Vol. 29, No. 6, 739-44 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 663-8 (Dec., 1959).

The conditions are determined for which the density of secondary particles in an electron beam is considerably greater than the density of primary electrons. An investigation is made of the equilibrium conditions for such a beam.

537.533

9085 PROPAGATION OF PERTURBATIONS IN A ONE-DIMENSIONAL TWO-BEAM ELECTRON FLOW. Chzhan Dzhi-min. [Chang Chih-ming].
Zh. tekh. Fiz., Vol. 29, No. 6, 745-55 (June, 1959). In Russian. English translation in: Soviet Physics – Technical Physics (New York), Vol. 4, No. 6, 670-9 (Dec., 1959).

A solution is given for an arbitrary potential distribution. Various particular potential distributions are considered : (1) linear; (2) space charge; (3) constant potential in space (drift tube). The drift problem is solved, taking account of the presence of a transverse field.

537.533

9086 METHOD OF BUNCHING FAST ELECTRONS. S.P.Kapitsa.
Zh. tekh. Fiz., Vol. 29, No. 6, 729-31 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 654-6 (Dec., 1959).

The method of bunching electrons by conversion of velocity modulation into density modulation in drift space cannot be applied to relativistic electrons. A method is suggested which is based on the fact that the time of rotation of an electron in a magnetic field is proportional to its total energy. The theory is developed and limiting factors discussed. J.W.Sturgess

537.533

9087 SHORT MAGNETIC LENS WITH DISTRIBUTED WINDING. V.M.Kel'man, B.P.Peregud and V.I.Skopina.
Zh. tekh. Fiz., Vol. 29, No. 10, 1219-24 Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1118-22 (April, 1960).

The varying distribution of ampere-turns required to form an axial magnetic field of bell shape $\{H = H_0[1 + (z/a)^2]^{-1}\}$ is found by application of Glaser's general solution of the integral equation involved. Three designs of lens (with a = 28,34 and 60 cm) are calculated, and measurements on the field distribution of two of them constructed with multi-layer windings are compared with those on a conventional short-winding lens. The advantages of this type of lens in respect of weight and power consumption, and in the reduction of fringing field, are discussed. B.Meltzer

537.533

9088 STRONG-FOCUSING LENS WITH CYLINDRICAL POLE PIECES. I.A.Shukeilo.
Zh. tekh. Fiz., Vol. 29, No. 10, 1225-7 (Oct., 1959). In Russian. English translation in Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1123-5 (April, 1960).

An estimate is made of the field nonlinearity of lenses in which the pole-piece cross-section is defined by an arc which is almost hyperbolic. The arc radii for which the field nonlinearity is a minimum are determined.

537.533 : 621.385.833

9089 SPHERICAL ABERRATION DUE TO INITIAL PATH ANGLE AND LENS CURVATURE IN APERTURE ELECTRON LENSES. L.A.Harris.
Proc. Inst. Radio Engrs, Vol. 48, No. 3, 368-9 (March, 1960).

Thin-lens electron optics of an aperture in (a) a spherical and (b) a cylindrical electrode are discussed: an extension of the Davisson–Calbick theory for a plane electrode is given, assuming zero field on the exit side but not making the paraxial approximation. B.Meltzer

537.533 : 533.7

9090 ENERGY ANALYZER FOR ELECTRON DIFFRACTION BY GASES. D.A.Swick.
Rev. sci. Instrum., Vol. 31, No. 5, 525-8 (May, 1960).

A velocity analyser has been constructed for use in the diffraction of fast electrons by gases as well as solids. The angular distributions of elastically and of inelastically scattered electrons are electrostatically separated, and are simultaneously recorded on photographic plates. Coherent inelastic scattering patterns from CCl_4 vapour and C_6H_6 vapour have been obtained.

537.533 : 539.2

9091 COLLECTIVE LOSSES OF FAST ELECTRONS IN THEIR PASSAGE THROUGH MATTER. V.P.Silin.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 273-82 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 192-8 (Jan., 1960).

The energy losses of fast electrons passing through thin films are considered from the viewpoint of the theory developed by Frank, Tamm and Fermi (Abstr. 2082 of 1937; 1626 of 1940) taking into account spatial dispersion of the dielectric constant. An expression is derived for the longitudinal dielectric constant which takes account of exchange effects in a high density electron gas. The phenomenological theory developed by Landau (Abstr. 8604 of 1956) is used to determine the longitudinal and transverse dielectric constants of a degenerate electron fluid. It is shown that these quantities have singularities corresponding to the propagation of zero sound. The fast-electron losses associated with the excitation of both transverse and longitudinal zero sound are discussed. The dependence of the discrete losses on the scattering angle of fast particles in passage through optically anisotropic bodies is considered.

ION EMISSION . ION BEAMS

537.534 : 537.52

9092 EMISSION OF RELATIVELY HIGH-ENERGY IONS FROM LOW-VOLTAGE ARCS. E.R.Harrison.
Nature (London), Vol. 184, 245-6 (July 25, 1959).

Describes experiments with a type of low-voltage (40 to 80 V) arc, between a heated W, Mo or Ta cathode and a Ni anode in an atmosphere of argon (pressure 1 to 50 mm Hg), from which high-energy (100 to 750 eV) positive ions of cathode material are emitted through a hole in the anode into an evacuated (10^{-1} to 10^{-3} mm Hg) region beyond. It is suggested that the ions may gain their high energy from oscillatory electric fields in the constricted region of the arc formed by placing a diaphragm containing an aperture in front of the anode. J.Dutton

537.534 : 621.385.2

9093 THERMAL EMISSION OF ALKALI ION PULSES FROM CLEAN AND OXYGENATED TUNGSTEN. R.E.Minturn, S.Datz and E.H.Taylor.
J. appl. Phys., Vol. 31, No. 5, 876-9 (May, 1960).

The spontaneous emission of positive ions from a heated tungsten filament occurs as pulses, a single pulse releasing as many as 10^6 ions in less than 100 μsec. The pulses are composed mainly of potassium ions, present as impurities in the tungsten lattice. It is suggested that the emission of positive ions in the form of bursts is dependent upon the existence of edge dislocations in the metal. At temperatures where the formation of an adsorbed layer is possible, oxygen has a very pronounced effect upon the rate of emission of positive ion pulses.

537.534 : 621.385.2

9094 THERMAL POSITIVE ION EMISSION AND THE ANOMALOUS FLICKER EFFECT. S.Datz, R.E.Minturn and E.H.Taylor.
J. appl. Phys., Vol. 31, No. 5, 880-3 (May, 1960).

The correlation between the anomalous flicker effect in space charge limited diodes and the positive ion pulses which generate it is studied in the light of recent measurements of the size and shape thermal positive ion pulses from tungsten filaments. It is shown that the positive ion pulses, although smaller than the electron pulses, have similar duration times, and that the periodic structure of the

electron pulses may be quantitatively explained by reflection of the positive ion bursts back and forth through the region of maximum space charge.

537.534

9095 ON THE YIELD AND ENERGY DISTRIBUTION OF SECONDARY POSITIVE IONS FROM METAL SURFACES. H.E.Stanton.
J. appl. Phys., Vol. 31, No. 4, 678-83 (April, 1960).

The kinetic energy distribution of secondary positive ions liberated from a solid metallic target of beryllium under bombardment by positive ions was measured in a mass spectrometer provided with an energy analyser. In conformity with earlier investigations, it was found that an appreciable fraction of the ions was liberated with energies less than 5-10 eV, although some secondary ions of more than 200 eV were found. The distributions appeared to be at least partially Maxwellian in character. Although errors in measurement were large, there appeared to be little dependence of the yield of secondary ions on the mass of the bombarding ion.

537.534 : 621.385.032.22

9096 EVOLUTION OF GASES AND IONS FROM DIFFERENT ANODES UNDER ELECTRON BOMBARDMENT. J.R.Young.
J. appl. Phys., Vol. 31, No. 5, 921-3 (May, 1960).

With the aid of a bakeable mass spectrometer a study has been made of the material evolved from Ag, Cu, Ni, Mo, Ta, Ti, and W anodes exposed to oxide cathodes. Chlorine was found to be evolved from all the anodes during the first period of bombardment. No evidence of the dissociation of the thin films of BaO or SrO on the anodes was obtained, suggesting it does not play a significant role in oxide cathode poisoning. It is believed that the Cl evolution may be responsible for the early slump in emission commonly observed at low anode voltages from oxide cathodes. Evolution of O^+ ions was observed from oxidized Cu, Ni, Mo, Ta, and Ti with efficiencies up to approximately 10^{-5} ions/electron for electron energies of 90 eV and current densities of 10 mA/cm^2. This O^+ evolution reduced considerably the d.c. emission capabilities of the oxide cathodes. It was found that heating the anodes from 700° to 1000°C for long periods of time does not always eliminate all evolution products caused by electron bombardment. Hydrogen was observed to be evolved from Ti, and O^+ ions were observed from formerly oxidized Cu, Ni, Mo, and Ta, immediately after outgassing at temperatures less than 1000°C.

537.534

9097 SOME INVESTIGATIONS AND IMPROVEMENTS ON HIGH CURRENT, H.F. [ION] SOURCES. J.Depraz.
J. Phys. Radium, Vol. 19, No. 1, 86-7 (Jan., 1958). In French.

Peak currents of 4 mA at about 200 W r.f. and average currents of 1 mA with very little r.f. power, about 30 W, have been obtained.

537.534

9098 THE THERMAL-EMISSION ION SOURCE IN SOLID SOURCE MASS SPECTROMETRY. G.H.Palmer.
J. nuclear Energy, Vol. 7, No. 1-2, 1-12 (Aug., 1958).

The use of a thermal-emission ion source in a mass spectrometer is discussed in the light of the fractionation errors, and the difficulties of background spectra when using high-sensitivity electron multiplier ion detectors. New techniques are described for the analysis of lithium, boron, cadmium and tungsten which overcome some of the difficulties normally encountered, and the advantages of "solids" techniques are illustrated by considering the analysis of sub-microgramme quantities of lead, uranium and plutonium.

537.534

9099 NEW METHOD OF SAMPLE INTERCHANGE IN A SOLID-SOURCE MASS SPECTROMETER. B.R.F.Kendall.
J. sci. Instrum., Vol. 37, No. 4, 130-1 (April, 1960).

An ion source is described in which any one of a number of samples on a single filament can be analysed at will. The operation of the source is based on the effects of potential variations along the length of the filament. Results obtained with this and other experimental sources are discussed.

537.534 : 539.12

9100 THE PRODUCTION OF INTENSE ION PULSES OF LESS THAN 5×10^{-10} SEC DURATION. N.N.Fieror and E.A.Tamanov.
J. nuclear Energy, Vol. 8, No. 1-3, 91-2 (Nov., 1958). English translation of article in: Atomnaya Energiya, Vol. 3, No. 7, 44 (1957).

A method of producing neutron pulses, similar to that used in klystrons for the production of short electron pulses has been developed. Ions enter the system at different times with differing speeds but are caused to group together and strike the target in a very short time interval. A 200 keV ion beam is periodically deflected by an alternating electric field of frequency 5 Mc/s thus causing the beam to pass through the slit in the diaphragm once every cycle. Between the deflecting plates and the diaphragm, are situated two hollow electrodes which are connected to a r.f. generator giving an output of 250 W at 5 Mc/s. The length of the hollow electrodes and the frequency of the applied voltage are so chosen that, during the time of flight of the ions inside each electrode, the phase of the r.f. voltage changes by 180°. Thus, ions of differing velocities going through the diaphragm at various times, are bunched, giving a pulse current of small duration on the target.

537.534

9101 MULTISTAGE ELECTROSTATIC ENERGY ANALYSER WITH TWO-DIMENSIONAL FOCUSING. M.M.Bredov.
Zh. tekh. Fiz., Vol. 29, No. 8, 1032-8 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 940-5 (Feb., 1960).

A possible version of an electrostatic energy analyser is computed. It is shown that, upon reflection from an electrostatic mirror (created by hyperbolic cylindrical electrodes), it is possible to obtain simultaneous angular focusing of second-order accuracy, if the plane of symmetry of the field is included, or of first-order accuracy in the transverse plane. For multiple reflections from a mirror of this type, i.e. from a multistage device, it is possible to vary the relationship between the longitudinal and transverse slits of the apparatus within wide limits for a given dispersion.

537.534

9102 CONVERGENCE OF MAGNETIC SECTORS WITH SHAPED EDGES. M.Vivargent.
J. Phys. Radium, Vol. 18, No. 8-9, 537-8 (Aug.-Sept., 1957). In French.

The particle-converging properties of magnetic sectors with shaped edges, earlier obtained for the very general case, are listed in a simplified notation conveniently applicable to practical cases.
A.E.I. Research Laboratory

537.534

9103 A MODIFIED ION SLIT LENS FOR VIRTUAL VARIATION OF SLIT WIDTHS. A.J.H.Boerboom.
Z. Naturforsch., Vol. 15, No. 4, 350-5 (April, 1960).

It is shown that a slit lens system can be greatly improved by introducing a potential on one of the electrodes, which previously was at zero potential. The focusing at the collector is unaltered within optical aberrations of the third order and the range of adjustment is increased as compared with the original system. Experimentally it was found that the virtual collector slip width could be adjusted from 1 mm down to 0.15 mm, maintaining a fair peak shape.

537.534

9104 USE OF A QUADRUPOLE LENS IN MASS-SPECTROGRAPHY. H.L.César and J.M.Delfosse.
Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 69-74 (1960). In French.

Design data are given for a quadrupole electrostatic lens which greatly reduces the energy spread of ions from sources used in mass spectrographs.
B.Meltzer

537.534

9105 ABERRATION-FREE MASS SPECTROMETER WITH RADIAL INTERMEDIATE IMAGE. H.Wollnik and H.Ewald.
Z. Naturforsch., Vol. 15a, No. 3, 265-7 (March, 1960). In German.

The results of calculations, on an electronic computer, of the characteristics of 69 double-focusing mass spectrometers are presented in 8 graphs (Abstr. 1167 of 1960).
B.Meltzer

537.534

9106 AN ION CAGE. W.Paul, O.Osberghaus and E.Fischer.
Forschungsber.Wirtsch.-Verkehrsmin. Nordrhein-Westfalen, No. 415, 42 pp. (1958). In German.

Analysis (employing Ne stability theory of Mathiens' equation), construction and performance measurements on a vacuum system with electrodes so shaped as to provide a high-frequency electric field, the magnitude of which is proportional to the distance from a

centre point in all directions. Injected ions of given mass and charge, for suitable choice of frequency and field strength, perform 3-dimensional oscillations about the centre. The existence of stable oscillations is demonstrated by means of resonance absorption, in a manner similar to Purcell's nuclear resonance method. The system may be used for mass spectrometry. B.Meltzer

537.534

9107 ENERGY DISTRIBUTION OF SPUTTERED AND SCATTERED IONS IN BOMBARDMENT OF TANTALUM AND MOLYBDENUM BY POSITIVE CAESIUM IONS. V.I.Veksler. Zh. eksper. teor. Fiz., Vol. 38, No. 2, 324-34 (Feb., 1960). In Russian.

A method for investigation of the energy spectra of scattered and sputtered ions emitted from metals bombarded with positive ions is described. Investigations were carried out on the energy spectra of Cs^+, Mo^+ and Ta^+ ions obtained by bombarding molybdenum and tantalum targets ($T \sim 1600$-1800^0K) with Cs^+ ions possessing an energy U = 900-2150 eV. The sputtering and scattering components were separated from the previously determined secondary-emission ion spectra and the result was a significant decrease of the energy-limit in the spectrum of Cs^+ ions scattered by Mo. In the case of Mo^+ ions the width of the sputtered ion spectrum was 30-35 eV and for Ta^+ ions it was 35-50 eV, which is much higher than the value of 5 eV cited in the literature. This indicates that the probability of ionization of a sputtered atom escaping from the surface increases with increase of the atom energy.

537.534

9108 ON THE RANGE-ENERGY RELATION FOR $_3Li^6$ IONS IN NUCLEAR EMULSIONS. Nguyen-Huu-Tri. C.R.Acad. Sci. (Paris), Vol. 250, No. 11, 2016-18 (March 14, 1960). In French.

Six measurements were made between 0.75 and 2 MeV and agreed with previous values. The relation for $_3Li^6$ ions was also studied. E.J.Burge

537.534

9109 SPUTTERING OF COPPER BY HYDROGEN IONS POSSESSING ENERGIES UP TO 50 keV. N.V.Pleshivtsev. Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1233-40 (Nov., 1959). In Russian.

Dependence of the sputtering coefficient S (atoms/ion) on the energy, angle of incidence and mean ion current density was investigated by means of an ion gun. The angular distribution of the sputtered particles and the micro-relief of the surface were also studied. It was found that $S \sim (\ln E)/E$ for ion energies E = 15-55 keV. The sputtering coefficient increases with increase of the angle of incidence and within a certain range it is independent of the mean beam current density. For normal and oblique incidence of the beam the angular distribution of the sputtered particles differs significantly from the cosine law. "Grooves" are formed along the direction of incidence of the beam when the latter strikes the surface at an oblique angle. The data indicate that at intermediate ion energies momentum transfer is of greatest importance in the elementary sputtering act.

537.534

9110 HIGH-ENERGY SPUTTERING. O.C.Yonts, C.E.Normand and D.E.Harrison, Jr. J. appl. Phys., Vol. 31, No. 3, 447-50 (March, 1960).

Sputtering ratios for copper were determined in the energy range 5-40 keV for bombardment by A^+, He^+, and D^+. Argon values range from 6.48 at 5 keV to 9.25 at 27.5 keV, deuterium from 0.048 at 10 keV to 0.023 at 44 keV, and helium from 0.23 at 15 keV to 0.75 at 40 keV. Preliminary data are included for 30 keV sputtering of copper by H^+(0.011), D^+(0.03), He^+(0.13), N^+(5.28), Ne^+(3.61), A^+(9.02), Cu^+(9.60), Kr^+(15.15), and U^+(20.9). Also included are sputtering radios at 30 keV for A^+ on Ta(2.7), Mo(3.31), and Al(2.38). Most of these data are the result of a single measurement, and require further verification. A definite pressure dependence of the sputtering ratio for A^+ on Cu was found in the range of 0.04 to 0.08μ.

PARTICLE ACCELERATORS

537.54

9111 BOLTZMANN EQUATION FOR AN ELECTRON GUIDE FIELD ACCELERATOR. II. STABILITY ANALYSIS FOR AN ELECTRON BEAM. J.B.Ehrman. Phys. of Fluids, Vol. 3, No. 2, 303-17 (March-April, 1960).

The short time behaviour of the quasi-stationary solution of Pt I (Abstr. 3817 of 1960) is investigated by linearizing the Boltzmann equation in the perturbations. By the use of a suitable boundary condition on the distribution function in phase space, four one-dimensional coupled inhomogeneous Fredholm equations of the second kind are obtained for Fourier components of the Laplace transforms with respect to time of the perturbation charge-current density components. The asymptotic time behaviour of the perturbations is determined by that root of the Fredholm determinant (considered as a function of s, the Laplace transform variable) whose real part is algebraically greatest, provided that this real part is nonnegative. If the real part is negative, then the asymptotic time behaviour is sometimes determined by this root of the determinant and sometimes by branch points of the kernel on the imaginary axis. If the determinant has no roots for Re $s > 0$ and no multiple roots for Re $s = 0$, the quasi-stationary solution is stable. For the azimuthally symmetric Fourier components, the equation for ρv_θ is not coupled to the others and is studied in more detail. In the approximate betatron regime, the Landau damping rate for this mode is estimated without use of the Fredholm determinant. In the extreme betatron regime, the undamped vibration frequencies are obtained.

537.54

9112 ON THE PROBLEM OF PARTICLE BUNCHING IN A TRAVELLING WAVE LINEAR ACCELERATOR. G.I.Zhileiko. J. nuclear Energy, Vol. 8, No. 1-3, 159-62 (Nov., 1958). English translation of article in: Atomnaya Energiya, Vol. 3, No. 9, 245 (1957).

537.54 : 539.12

9113 A 340 kV ACCELERATOR FOR THE STUDY OF REACTIONS INDUCED BY TRITONS. D.Magnac-Valette, M.Suffert, M.Liess and P.Cüer. J. Phys. Radium, Vol. 19, No. 1, 88-91 (Jan., 1958). In French

An accelerator using electrostatic high tension is described. It is specially designed for triton acceleration. It gives a sharply focused beam with low gas consumption and a very high percentage of atomic ions. A special magnetic deflection is added to it, which focuses the beam at 120° to the initial direction. The accelerator can work with a mixture of H^3 and H at a weak concentration of H^3, as the large percentage of atomic ions makes the triatomic hydrogen beam so poor that the observation of triton induced reactions is not impaired.

537.54

9114 DESIGN CRITERIA FOR HIGH ENERGY ELECTRON LINEAR ACCELERATORS. G.A.Zeitlenok, V.V.Rumyantsev, V.L.Smirnov, L.P.Fomin, V.K.Khokhlov, I.A.Grishaev and P.M.Zeidlits. J. nuclear Energy, Vol. 9, No. 1-4, 230-9 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 448 (1958).

The choice of basic characteristics in the design of linear accelerators for electrons of high energy is discussed. The way the overall length, the number of sections, the input power and the cost of construction and operation depend on the magnitude of the electric field intensity at the axis of the wave guide, which consists of sections fed independently by high frequency generators, is determined. The minimum cost of construction and operation is independent of the final electron energy. It is shown that the sections are most advantageously fed by high frequency generators of the highest possible power (greater than 20 MW). The question of increasing the duration of the effective part of the high frequency pulse is also discussed.

537.54

9115 VARIABLE-PHASE FOCUSING IN LINEAR ACCELERATORS. Ya.B.Fainberg. Zh. tekh. Fiz., Vol. 29, No. 5, 568-79 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 506-16 (Nov., 1959).

A method of variable-phase focusing is proposed and investigated. The phase and radial motions are considered, and the relation between them is investigated. Other possible applications of variable-phase focusing are indicated.

537.54 : 537.533

9116 DECOUPLING OF THE OSCILLATIONS ABOUT A CENTRAL TRAJECTORY IN AN ELECTROMAGNETIC FIELD. APPLICATION TO CIRCULAR ACCELERATORS. F.Fer. Cahiers der Phys., Vol. 13, 29-52 (Sept., 1959). In French.

Mathematical analysis of small perterbations of the relativistic motion of a charged particle on a given trajectory in the most general electromagnetic field, shows that while it is difficult in general to reduce them to independent normal modes of oscillation, a moving coordinate system may always be defined for which the three equations of displacement take the form

$$\frac{d^2 l^i}{d\tau^2} + \sum_{k=1,2,3} Q_k^i l^k = 0$$

Here l^i are the coordinates, τ the proper time and Q_k^i a symmetric matrix, which is a function of τ and the field. Difficulties in the application of this result, as well as particular applications to the stability of cyclotrons, are discussed. B.Meltzer

537.54

9117 DESIGN OF A MAGNET FOR A FREQUENCY-MODULATED RING CYCLOTRON.

V.N.Kanunnikov and A.P.Fateev.
Zh. tekh. Fiz., Vol. 29, No. 10, 1228-34 (Oct., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10,1126-32 (April, 1960).

Using the magnetostatic potential, a relation is found for the density of magnetization current in the radial direction for a frequency-modulated ring cyclotron with distributed-windings. The problem is solved under the assumption that the permeability of the iron is infinitely large. The magnetostatic potential method is also used for computing the distortions in the magnetic field due to inaccuracies in the current distribution, edge effects, and other factors.

537.54

9118 CYCLOTRON WITH AN OBLIQUE ACCELERATING GAP. N.K.Abrosimov.
Zh. tekh. Fiz., Vol. 29, No. 6, 726-8 (June, 1959). In Russian.
English translation in : Soviet Physics —Technical Physics (New York), Vol. 4, No. 6, 651-3 (Dec., 1959).

The principle of the cyclotron with a curved accelerating gap intended to overcome relativistic effects, suggested by Varshni [Nuclear Instrum. and methods, Vol. 1, 280 (1957)], is analysed and shown to be unpracticable. J.W.Sturgess

537.54

9119 CONSIDERATIONS RELATING TO THE CHOICE OF THE DEE VOLTAGE IN A CYCLOTRON.

Yu.A.Zavenyagin and N.D.Fedorov.
J. nuclear Energy, Vol. 8, No. 1-3, 95-9 (Nov., 1958). English translation of article in: Atomnaya Energiya, Vol. 3, No. 7, 50 (1957).

537.54

9120 MOTION OF CHARGED PARTICLES IN THE CENTRAL REGION OF A CYCLOTRON. V.S.Panasyuk.
J. nuclear Energy, Vol. 8, No. 4, 256-9 (Jan., 1959). English translation of article in: Atomnaya Energiya, Vol. 3, 341 (1957).

537.54

9121 SUGGESTIONS FOR THE UTILIZATION OF THE ION BEAM MODULATION IN A CYCLOTRON FOR CONTROL PURPOSES. V.S.Panasyuk.
J. nuclear Energy, Vol. 8, No. 1-3, 92-5 (Nov., 1958). English translation of article in: Atomnaya Energiya, Vol. 3, No. 7, 47 (1957).

537.54

9122 THE 225-cm CYCLOTRON AT THE NOBEL INSTITUTE OF PHYSICS, STOCKHOLM.

H.Atterling and G.Lindström.
Ark. Fys., Vol. 15, Paper 36, 483-502 (1959).

A description is given of the 225 cm fixed-frequency cyclotron at the Nobel Institute of Physics in Stockholm. This cyclotron has operated reliably and stably for several years producing internal beams of protons, deuterons, alpha particles and heavy ions. The nominal energy attained at a radius of 90 cm with the present oscillator frequency is about 11 MeV per nucleon. So far, internal deuteron beam currents up to approximately 300 μA at a nominal energy of about 22 MeV have been normal. An unusual feature possessed by this cyclotron is the dee biasing system based on the use of condensers as electrical terminations of the dee stems.

537.54

9123 THE ACCELERATION OF HEAVY IONS IN THE STOCKHOLM 225-cm CYCLOTRON. H.Atterling.
Ark. Fys., Vol. 15, Paper 39, 531-58 (1959).

A description is given of the acceleration and bombarding techniques used in the work on heavy ions with the 225-cm cyclotron at the Nobel Institute of Physics, Stockholm. With the present oscillator frequency this machine can accelerate heavy ions with mass-to-charge ratios up to about 3.7. The nominal energy at a radius of 90 cm (exit radius) is about 11 MeV per nucleon. Some results of an investigation of the energy distribution of $(C^{12})^{4+}$ beams are reported. It is shown that this distribution contains, together with the high-energy peak of $(C^{12})^{4+}$ ions, a low energy component. At a radius of 80 cm, where the mean energy for the $(C^{12})^{4+}$ peak is roughly 100 MeV, the low-energy component has a distribution maximum below 30 MeV.

537.54 : 539.12

9124 COHERENT ELECTRON RADIATION IN A SYNCHROTRON. II. L.V.Iogansen and M.S.Rabinovich.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 118-24 (July, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 83-7 (Jan., 1960).

For Pt I, see Abstr. 2426 of 1959. The electromagnetic interaction of electrons in a thin relativistic bunch in coherent radiation is considered. The tangential forces exerted on an individual electron by the bunch are considered for different particle phase distributions.

537.54

9125 AN UPPER LIMIT TO FREQUENCY IN A SYNCHROTRON. E.M.Moroz and M.S.Rabinovich.
J. nuclear Energy, Vol. 9, No. 1-4, 115-19 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 128 (1958).

The energy dependence of the amplitude of synchrotron oscillations caused by fluctuations in radiation is investigated. A simple stationary solution for the phase equation is obtained which, in practice, is valid with sufficient accuracy for all large synchrotrons. It is shown that, if electrons are accelerated up to several GeV, the admissible frequency is subject to a sharp upper limit determined by the maximum amplitude of the accelerating voltage.

537.54

9126 RESONANT PERTURBATIONS OF SYNCHROTRON OSCILLATIONS IN HEAVY-PARTICLE ACCELERATORS.
I.S.Danilkin and M.S.Rabinovich.
Zh. tekh. Fiz., Vol. 27, No. 7, 1558-70 (July, 1957). In Russian.

Synchrotrons and similar accelerators are considered. The influence of harmonic perturbations on phase motion and on the acceleration particles is examined. Calculations are compared with experimental results obtained from the 10 GeV synchrotron at Dubna. The results obtained allow the estimation of permissible tolerances in the radiofrequency system, magnet etc. J.H.Fremlin

537.54

9127 CHARACTERISTIC FUNCTIONS FOR THE BETATRON OSCILLATIONS IN A RING SYNCHROTRON.

Zh.Loshak.
Zh. tekh. Fiz., Vol. 29, No. 8, 995-1008 (Aug., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 904-17 (Feb., 1960).

An investigation is made of the characteristic oscillations in a simplified model of an accelerator with an alternating radial field. Analytic expressions and the basic properties of these oscillations are determined. Consideration is given to their extension for study of "resonance lines" and the effect of distortions in the magnetic field.

537.54

9128 THE DAMPING OF OSCILLATIONS IN A SYNCHROTRON. E.M.Moroz and M.S.Rabinovich.
Zh. tekh. Fiz., Vol. 29, No. 2, 269-71 (Feb., 1959). In Russian.

English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 2, 236-8 (Feb., 1959).

The effects of various factors on the damping of particle oscillations are considered. The damping of phase oscillations cannot be analysed separately from the problem of the quantum fluctuations of radiation from the electrons. An expression is given for this effect which holds in practice for large synchrotrons with normal (not strong) focusing. J.W.Sturgess

537.54

9129 INVESTIGATION OF THE TRANSIENT CURRENT IN A BETATRON.

D.P.Ivanov, A.P.Komar and Yu.S.Korobochko.
Zh. tekh. Fiz., Vol. 29, No. 10, 1235-44 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1133-40 (April, 1960).

A relationship between the transient current during capture, the injector emission current and the mean number of electron revolutions is established. Experiments on the variation of transient current with time and the effect of various factors appearing in the capture process on the mean number of turns are reported. The methods are applicable as means of simplified adjustment of betatrons and sealed-off betatrons. J.W.Sturgess

537.54

9130 NOTE ON BETATRON CAPTURE.

L.M.Kovrizhnykh and A.N.Lebedev.
Zh. tekh. Fiz., Vol. 29, No. 6, 732-7 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 657-62 (Dec., 1959).

Some interaction mechanisms leading to electron capture in betatrons are discussed briefly. The method of taking into account collective interactions of particles in capture mechanisms (Abstr. 8036 of 1958) is developed omitting the previous limitation that all the injected electrons have equilibrium energies. An analysis is made of the physical interpretation of the capture mechanism. J.W.Sturgess

537.54

9131 CAPTURE MECHANISM IN BETATRONS.

I.M.Samoilov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 705-12 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 504-8 (March, 1960).

The motion of electrons in a betatron is considered, taking into account the Coulomb repulsion of the particles in the beam injected into the chamber during one revolution of an electron. It is shown that electron capture is due to the change in the mode of the radial oscillations, caused by the repulsion of the particles in the beam, and to the loss of electrons as a result of collisions with the injector or chamber walls.

537.54 : 530.12

THE CLOCK PARADOX FOR THE MOTION OF ELECTRONS IN A BETATRON. See Abstr. 8543

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

538

9132 FRICTIONLESS RECORDING TORQUE MAGNETOMETER.

A.A.Aldenkamp, C.P.Marks and H.Zijlstra.
Rev. sci. Instrum., Vol. 31, No. 5, 544-6 (May, 1960).

An instrument for measuring magnetic anisotropy by recording magnetic torque curves is described. The special construction of the transducer which converts the torque exerted on the sample into an electric signal makes it possible to avoid bearings, so that the instrument is essentially free of friction. The instrument is operated with commercially available electronic apparatus and is suitable for routine measurements on large numbers of samples. The maximum sensitivity is 150 d cm per centimetre deflection of the recorder stylus.

538

9133 A NULL METHOD FOR THE MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF MAGNETIC MOMENT. G.Atanasiu and S.Pătrașcu.
Rev. de Physique (Bucarest), Vol. 4, No. 3, 273-82 (1959). In French.

Describes the construction and use of an astatic magnetometer of use in geomagnetic investigations. The temperature range covered is -4° to $+51^{\circ}$ C. E.P.Wohlfarth

538 : 621.317.44

9134 PRACTICAL HYSTERESIGRAPH.

R.R.Bockemuehl and W.E.Sargeant.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 1828-1828 (May, 1960).

A relatively low-cost hysteresigraph has been developed which is suitable for both laboratory and industrial application. The instrument utilizes standard component parts and employs mutual inductance feed-back to perform the necessary integrating operation. The instrument is reasonably insensitive to environment and permits direct recordings of hysteresis loops and magnetization curves to be made in less than one minute. Both theoretical and practical considerations of the instrument are presented.

536

9135 ON THE VOLTAGE SENSITIVITY OF HALL E.M.F. PROBES. V.V.Galavanov.
Fiz. tverdogo Tela, Vol. 2, No. 1, 62-4 (Jan., 1960). In Russian.

A discussion of which materials and temperatures to use in order to obtain a large sensitivity γ (the ratio of the Hall voltage to the magnetic field) with a sufficiently small temperature dependence. R.G.Stinchcombe

538 : 621.374.32 : 621.318.12

9136 DEVELOPMENT OF HIGH-SPEED COINCIDENT CURRENT MEMORY CORES. B.R.Eichbaum.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 1178-1188 (May, 1960).

In present day large computers the memory cycle is of the order of 8 μsec requiring memory cores to switch in 1.5 μsec with a full select drive of approximately 0.7 A. Memory cores used in such a computer can be fabricated from a $MgO \cdot MnO \cdot Fe_2O_3$ ferrite material. Using the same ferrite material, memory cores have been developed which have a switching speed of 0.4 μsec with a full select drive of approximately 1.0 A. The procedure used to developed these high-speed coincident current memory elements is described. The drive current is reduced to approximately 0.7 A when partial substitutions of CaO and Cr_2O_3 are made for MgO and Fe_2O_3 respectively in the $MgO \cdot MnO \cdot Fe_2O_3$ core composition.

538 : 621.374.32 : 621.318.12

9137 FERRITE FILMS — NEW LOGIC AND STORAGE DEVICES.

J.M.Brownlow, W.L.Shevel, Jr. and O.A.Gutwin.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 1218-1228 (May, 1960).

Magnetic devices for storage and switching applications in digital computers have been fabricated in the form of open flux path elements. The geometry employed is that of a planar film with thicknesses in the range of five to fifty microns and other dimensions in the fractional inch range. These elements have the advantages of a ferrite composition and of open flux paths without many of the disadvantages present in similar metallic devices. For use in storage systems, these devices possess excellent squareness characteristics and have coincident selection times comparable with ferrite toroidal devices. Properties of these devices are given in terms of switching curves, low frequency hysteresis loops, and one to zero signal ratios. Other aspects that are discussed include disturb sensitivity of storage elements, heating effects due to high pulse repetition frequency, and mechanical properties. For each of these comparison is made with other types of magnetic elements such as toroids and metallic films. Applications are discussed in terms of drive requirements, packing densities, and switching times.

538 : 541.13 : 621.374.32 : 621.357.7 : 621.318.12

9138 ELECTRODEPOSITED MEMORY ELEMENTS FOR A NONDESTRUCTIVE MEMORY. T.R.Long.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 1238-1248 (May, 1960).

Nickel-iron films are being electrodeposited on to a wire substrate to form memory elements for a fast, nondestructive memory. By plating in the presence of a directed magnetic field, an anisotropy

favouring circumferential orientation is established. Axial interrogation fields cause reversible rotations of less than 90° and produce output signals across the ends of the wire. The apparatus and techniques used to make this wire are discussed together with the rationale back of the design. The choice of alloy composition and the plating conditions strongly affect the results. The amount of stress in the deposit, the residual stress in the substrate, the control of precleaning of the substrate, the use of a suitable wetting agent, and the degree of stirring in the electrolyte appear as the vital factors in obtaining consistent results. Moderate fields (~30 Oe) applied during plating produce a preferred circumferential orientation with high anisotropy ($H_k/H_0 = 3.0$). Squareness ratio in the easy direction is 0.99. Output signals appear during the rise time of the interrogation pulse with an amplitude inversely related to the rise time and directly proportional to the length interrogated. Very fast switching with unusually high output signals per unit length are possible. Selective write-in is possible with current margins of 3:1. Preliminary investigations indicate that it would be feasible to make plated wire on a production basis with properties suitable for memory applications.

538 : 621.318.1 : 621.374.32

9139 MINIATURE MEMORY PLANES FOR EXTREME ENVIRONMENTAL CONDITIONS.

R.Straley, A.Heuer, B.Kane and G.Tkach.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 126S-128S (May, 1960).

Two serious limitations of present memory systems by using ferrite cores have been their relative bulk and narrow operating temperature range. A marked reduction in size has been achieved by use of a "continuous wire" method of inserting drive lines through memory planes and then folding the planes. This method eliminates the conventional frames and all solder connections between planes. By greatly reducing the number of solder connections, the new method increases reliability and facilitates assembly of stacked memory planes. A typical folded stack of memory planes occupies as little as 2% of the volume of its conventional counterpart. The new miniature memory stacks perform as well as conventional units. The development of ferrite memory cores operable at ambients as high as 85°, 100° and 125°C (together with the greatly reduced volume of the memory stack) allows operation under extreme environmental conditions with a minimum of space and power requirements. The folded memory planes are packaged with a heating element and control circuit which maintain the temperature of the cores at the maximum ambient. A tested prototype of twelve 16 × 16 memory planes, along with the heating element and control circuit, measures 2 in. × 2½ in. × 2½ in. and has been successfully operated in the temperature range −55° to + 125°C. Ferrite cores have been perfected of both the "fast" relatively high drive and relatively "slow" lower drive type. They are Mg-Mn ferrites with possible minor additions of other bivalent oxides.

538 : 621.374.32

9140 NEW MULTI-APERTURE MAGNETIC LOGIC ELEMENT.

D.R.Bennion.

J. appl. Phys., Suppl. to, Vol. 31, No. 5, 129S-130S (May, 1960).

A new magnetic multi-aperture device (MAD) having general logic capability has been designed, constructed and tested. This device can be used for either direct or complementary transfer of binary information, depending only on a simple change in wiring. AND and OR logic functions can be performed in the interconnecting circuitry, which consists only of conducting wire. Significant operating tolerances have been exhibited by the new element, which is simpler in structure and associated wiring than previous MADs having the same logic capability.

538 : 621.318.12 : 621.374.32

9141 ELASTIC SWITCHING PROPERTIES OF SOME SQUARE LOOP MATERIALS IN TOROIDAL STRUCTURES.

W.C.Seelbach and J.R.Kiseda.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 135S-136S (May, 1960).

Elastic switching properties of some square-loop materials are presented and the concept of an elastic switching constant $S_{\omega(r)}$ is introduced. The plot of applied "turn over" field strength versus the inverse of the drive width indicates that the inelastic switching constant for a given material is four to five times greater than the elastic switching constant $S_{\omega(r)}$. The "turn over" field strength is defined to that value of field strength at which inelastic switching just starts and therefore is considered to be the upper limiting field strength for elastic switching. To a first-order approximation, the ratio of $S_{\omega(r)}$ to S_ω is shown to be equal to the percentage of the total flux capacity of the core that can be switched in an elastic mode of operation. $S_{\omega(r)}$ values for Molybdenum Permalloy ranged from 0.0374 Oe μsec for ½-mil tapes to 0.0913 Oe μsec for ½ mil tape.

538 : 621.374.32 : 621.318.2

9142 LOCALIZED FIELD PERMANENT MAGNET ARRAYS.

H.L.Stadler.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 196S-197S (May, 1960).

Very short bar magnets can be grouped into linear arrays in such a way as to give a more localized field than does a single magnet of about the same size. Shaping the field from small magnet arrays is particularly important in the design of permanent-magnet memories where the information is stored by the presence or absence of permanent magnets. To achieve high information density, it is necessary to design magnet structures with very localized fields. Measurements of the response of a memory sensing element as a function of its distance from various magnets show that a linear array has a much stronger effect when very close to the sensor than does a single magnet of similar size and dipole moment.

538.1

9143 PERMANENT MAGNET LEAKAGE PERMEANCE EVALUATION BASED ON POLAR RADIATION ANALOGY. J.E.Foy and R.J.Parker.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 188S-189S (May, 1960).

This paper is based on the premise that the permanent magnet can be considered as an equipotential body and hence electrostatic analogies can be used to advantage in evaluating permanent magnet leakage. The spherical pole formula, which is based on the substitution of a sphere having dimensions, which will make it the equivalent of the actual magnet limb in leakage effect, is described and its application to permanent magnet limb geometry is discussed. Evershed used this approach extensively with his work on the early steel permanent magnet. The authors review this work and explore the conditions affecting the use of this technique in modern permanent magnet materials. Reversible permeability and limb magnet area to cross-section area ratios are found to be influential in the location of the centre of the effective polar regions. Today's high coercive force permanent magnet with shorter limb lengths is found to be particularly well-suited to this polar radiation analogy, since the departure from the spherical shape is less extreme than was the case with the earliest low coercive steel magnets. Calculation of demagnetization factors for rods, rings, "U" and "C" shaped magnets are convenient and accurate arrived at by this approach. A geometric criterion is developed which allows magnet configurations to be considered either (a) open circuit (permeance due to limb radiation), or (b) closed circuit magnets where the proximity of the polar regions is such as to increase the free polar radiation. In closed circuit magnet arrangements, the free polar radiation occurs for at least half the magnet limb area so that the spherical pole formula represents a very useful technique in the evaluation of any permanent magnet configuration. To demonstrate the breadth of usage possible with the spherical pole formula a tubular-shaped magnet used as a magnetron field supply is analysed to show the utility of this approach in estimating the shape of the axial field characteristic and its relationship to geometry and permanent magnet unit properties.

538.1

9144 PRODUCTION OF VERY HIGH MAGNETIC FIELDS BY IMPLOSION.

C.M.Fowler, W.B.Garn and R.S.Caird.

J. appl. Phys., Vol. 31, No. 3, 588-94 (March, 1960).

Magnetic fields are produced in the 10-15 MG range by use of high explosives which compress the flux obtained from initial fields of approximately 10^5 G. The fields described here occupy a cylindrical volume and are essentially axial. A typical field might have these general characteristics: peak field 14 MG; 2 μ sec duration from 10-14 MG; field volume around peak, 6 mm diameter, 50 mm estimated length.

538.1 : 538.56

MAGNETS FOR HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTROMETERS. See Abstr. 7236

538.1

9145 ELECTROMAGNETS. L.Weil.

HIGH ENERGY COIL MAGNETS. N.Kurti.

PULSED MAGNETIC FIELDS. B.Lax.

Physica, Vol. 24, Supplement, S118-S122, S123-S124, S125-S127

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief reviews of the design of magnets of these types.

R.G.Chambers

538.1

9146 EXPERIMENTAL VERIFICATION OF THE THEORETICAL DISTRIBUTION OF THE MAGNETIZATION INTENSITY ALONG A CYLINDER. G.Grinberg.

Latv. PSR Zinat. Akad. Vestis, No. 9(146), 85-90 (1959). In Russian.

Wuerschmidt [Theorie des Entmagnetisierungsfaktors. Braunschweig (1925)] established a theoretical expression for the intensity of magnetization I along a cylinder of finite length, placed along the lines of force of constant magnetic field. The author shows that, in particular, for $\lambda = 50$ and $\varkappa = 15$, or 5, the Wuerschmidt's formula does not hold (λ = length/diameter ratio of the cylinder and $\varkappa$ = magnetic susceptibility) and explains the reason of this discrepancy, which is illustrated. J.K.Skwirzynski

538.1

9147 HOMOGENEOUS MAGNETIC FIELDS FOR THE OPTICAL INVESTIGATION OF FERROMAGNETIC SPECIMENS. H.Murrmann and C.Schwink.

Z. angew. Phys., Vol. 12, No. 4, 155-7 (April, 1960). In German.

Gives details of secondary coils whose magnetic fields, when correcting that in a neighbouring main coil with airgap, homogenize it. E.P.Wohlfarth

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

538.3

9148 PHENOMENOLOGICAL ELECTRODYNAMICS AND ELECTRO-THERMODYNAMICS IN LOW TEMPERATURES. R.S.Ingarden.

Physica, Vol. 24, Supplement, S178 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The general form of non-local and non-linear phenomenological electrodynamics in arbitrary material media is studied at constant temperature and entropy The theory is based on a variational principle, non-locality and non-linearity being connected with the material equations. The following special cases are discussed in detail: (1) ferromagnetic media; (2) ferroelectric media; (3) anomalous skin effect; (4) superconductivity. Special attention is given to hysteresis phenomena in the cases (1), (2). At the end the generalization of the theory for changing temperature and entropy (electrodynamics) is briefly discussed.

538.3 : 532.5 : 621.65 : 621.313.33

9149 ANALYTIC DETERMINATION OF THE POTENTIAL DISTRIBUTION IN THE BOUNDARY ZONE OF AN ELECTROMAGNETIC PUMP WITH CONSTANT CURRENT. Yu.Birzvalks.

Latv. PSR Zinat. Akad. Vestis, No. 12 (149), 49-58 (1959). In Russian.

The potential distribution function is obtained by means of conformal transformation of the solution of Laplace equation and by suitable choice of an analytic function in the Fourier transform of the potential series. J.K.Skwirzynski

538.3

9150 QUANTUM THEORY OF SPATIAL DISPERSION OF ELECTRIC AND MAGNETIC SUSCEPTIBILITIES. O.V.Konstantinov and V.I.Perel'.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 786-92 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 560-4 (March, 1960).

A general expression is obtained for the electric and magnetic susceptibilities when spatial dispersion is taken into account. It is shown that electromagnetic effects in a uniform medium can be described by means of a conductivity which depends on frequency and wave vector and a magnetic susceptibility which depends only on the wave vector. A universal relation is obtained between the conductivity and the magnetic susceptibility.

538.3

9151 ELECTROMAGNETIC ENERGY DENSITY IN DISPERSIVE MEDIA. F.Borgnis.

Z. Phys. Vol. 159, No. 1, 1-6 (1960). In German.

General expressions for electromagnetic energy densities and losses in dispersive media are derived. They depend, in general, on the way the fields are established. It is only when fields of harmonic time dependence are established extremely slowly that the energy becomes independent of the transient character of the field and can be represented by a simple expression.

538.3

9152 THE INFLUENCE OF THE CONDUCTIVITY OF THE SURROUNDING MEDIUM UPON THE INPUT IMPEDANCE OF A CURRENT LOOP. V.G.Zernyatko and D.N.Chetaev.

Zh. tekh. Fiz., Vol. 29, No. 8, 1009-13 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 918-22 (Feb., 1960).

Using Fok's solution (1926 and 1933) for the field of a l.f. current element lying on the surface of a conducting medium, the input impedance of a current loop (the latter being dependent upon the conductivity of the underlying medium) is computed by the method of induced e.m.f.'s.

538.3

9153 EDDY CURRENTS IN A MOVING SAMPLE. T.M.Sycheva.

Zh. tekh. Fiz., Vol. 29, No. 8, 1014-20 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 923-9 (Feb., 1960).

Investigates the field associated with the eddy currents induced in a body (finite thickness and permeability >1) moving in a d.c. magnetic field whose source is a magnetized filament located above the moving body. The formulae derived are analysed qualitatively. The conclusions drawn from the general theory were experimentally verified, using cylindrical specimens and a pair of knife-edged poles of an electromagnet.

538.3

9154 MOTION OF AN ELECTRON IN A SPATIALLY PERIODIC MAGNETIC FIELD. V.D.Fedorchenko, B.N.Rutkevich and B.M.Chernyi.

Zh. tekh. Fiz., Vol. 29, No. 10, 1212-18 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1112-17 (April, 1960).

An analysis is made of the motion of electrons in a magnetic field which is constant in time but which is modulated weakly in the longitudinal direction. Under certain conditions, a "resonance" relation obtains between the velocity of the electron, the fixed component of the magnetic field, and the period of the spatial modulation; in this case, the magnetic moment of electron is no longer conserved and the energy is divided between the longitudinal and transverse components of the motion.

538.3

9155 FIELD OF A CHARGED PARTICLE IN A MOVING MEDIUM. B.M.Bolotovskii and A.A.Rukhadze.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1346-51 (Nov., 1959). In Russian.

The field produced by a charge passing through a moving medium is considered. Energy losses due to emission of Cherenkov—Vavilov radiation and excitation of plasma waves are determined.

538.3 : 539.17

9156 SELF-CONSISTENT FIELD AND MOTION OF ELECTRONS WHICH HAVE A RANGE IN CANONICAL ANGULAR MOMENTUM IN A UNIFORM MAGNETIC FIELD. L.Tonks.

Phys. Rev., Vol. 118, No. 2, 390-8 (April 15, 1960).

For previous work, see Abstr. 9856 of 1959. The self-consistent theory of relativistic electrons circulating in a uniform magnetic field, the "Astron problem", has been generalized to the extent that a range of canonical momentum among monoenergetic electrons has been treated. For simplicity, the density distribution in phase space has been chosen to be uniform over a finite momentum range. Just as in the single-momentum case, field reversal is found, but new field and spatial density configurations appear. The uniform distribution is found to be consistent with isotropic regions of constant

spatial density and constant magnetic field. The thickness of transition layer between vacuum and such a region conforms, within limits, to an empirical relation previously found. The limit to the number of electrons per unit axial length of layer still exists. The curves relating the ratio of internal to external field to the layer strength still show multiple values of both ratio and strength in certain ranges. Trajectories have been calculated and plotted for several cases.

538.3

9157 ON A CORRESPONDENCE BETWEEN CERTAIN MAGNETOHYDRODYNAMIC FLOWS AND THOSE OF THE DYNAMICS OF GASES [IN THE ABSENCE OF A MAGNETIC FIELD]. R.Peyret.
C. R. Acad. Sci. (Paris), Vol. 250, No. 11, 1971-3 (March 14, 1960). In French.

It is shown that certain magnetohydrodynamic problems can be reduced to those of the dynamics of a fluid of fictitious thermodynamic properties appropriately chosen. H.N.V.Temperley

538.3

9158 MAGNETOHYDRODYNAMICS OF WEAKLY CONDUCTING LIQUIDS. S.I.Braginskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1417-30 (Nov., 1959). In Russian.

The approximate form of magnetohydrodynamic equations was derived for a liquid possessing a low electrical conductivity (small magnetic Reynolds numbers) and located in an external magnetic field. Some characteristic problems are considered which describe the physical nature of the behaviour of such liquids in a strong magnetic field.

538.3

9159 STABILITY OF EQUILIBRIUM OF A CONDUCTING LIQUID HEATED FROM BELOW IN A MAGNETIC FIELD. V.S.Sorokin and I.V.Sushkin.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 612-20 (Feb., 1960). In Russian.

The influence of a uniform magnetic field on the stability of equilibrium of a conducting liquid heated from below in a cavity of arbitrary form is investigated in a general form. The time variation of the perturbations appearing in the liquid is always monotonic. The critical value of the Rayleigh number, C_a^3, above which equilibrium is unstable increases monotonically with the Hartmann number M so that the inequality $dCo(M)/dM < Co(M)/M$ is observed. For small values of M the critical Rayleigh number is proportional to M^2, and the proportionality coefficient can be exactly evaluated. The asymptotic behaviour of the function $C_0(M)$ for $M \to \infty$ depends on the shape of the cavity and the direction of the field.

538.3

9160 THEORY OF CERTAIN MAGNETOHYDRODYNAMIC PHENOMENA OCCURRING IN THE FREE LAMINAR THERMAL CONVECTION OF AN ELECTRICALLY CONDUCTING FLUID IN A ROUND VERTICAL PIPE LOCATED IN A WEAK MAGNETIC FIELD. A.G.Smirnov.
Zh. tekh. Fiz., Vol. 29, No. 10, 1245-51 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1141-7 (April, 1960).

Considers the case where the magnetic action does not essentially distort the hydrodynamic currents, so that it is possible to refer to magnetic corrections.

538.3

9161 RELATIVISTIC HYDRODYNAMICS FOR A CHARGED NONVISCOUS FLUID. Chau-Chin Wei.
Phys. of Fluids, Vol. 3, No. 2, 323 (March-April, 1960).

The classicial vorticity theorem for a non-viscous fluid is generalized to the case of a relativistic electrically charged fluid in an electromagnetic field. O.Penrose

538.3

9162 ON THE REFLECTION AND REFRACTION OF MAGNETO-HYDRODYNAMIC WAVES.
S.Prakash and J.N.Tandon.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 4, 264-73 (1957).

The laws of reflection and refraction of magnetohydrodynamic waves from the surface of discontinuity of two infinitely extended and infinitely conducting fluid media of different densities and having different homogeneous permanent magnetic fields have been derived. The laws are quite simple and depend on the orientations of the magnetic field of the respective media. It is also shown that reflection and refraction are possible only provided the incident wave is polarized perpendicular to the plane of incidence and the discontinuity of the magnetic field is perpendicular to the plane of incidence.

538.3

9163 SIMPLE WAVES IN THE CHEW–GOLDBERGER–LOW APPROXIMATION.
I.A.Akhiezer, R.V.Polovin and N.L.Tsintsadze.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 756-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 539-41 (March, 1960).

Simple waves in a plasma with anisotropic pressure are treated. It is shown that there exist three types of simple wave. The direction of the variations of the magnetohydrodynamic quantities in these waves is investigated.

538.3

9164 SIMPLE WAVES IN MAGNETOHYDRODYNAMICS. A.I.Akhiezer, G.Ya.Lyubarskii and R.V.Polovin.
Zh. tekh. Fiz., Vol. 29, No. 8, 933-8 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 849-54 (Feb., 1960).

The relation between simple waves and ordinary plane waves is established. All the simple one-dimensional waves are considered. It is shown that, in the absence of shock waves, a region of constant flow can be bounded only by a simple wave.

538.3

9165 MOTION OF A CONDUCTING PISTON IN A MAGNETOHYDRODYNAMICAL MEDIUM.
I.A.Akhiezer and R.V.Polovin.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 529-33 (Feb., 1960). In Russian.

The types of waves excited in a hydromagnetic medium by a uniformly moving conducting plane (piston) are investigated. Decay of an initial discontinuity is discussed.

538.3

9166 INTRODUCTION TO THE STUDY OF MAGNETO-AERODYNAMICS. P.Germain.
Cahiers de Phys., Vol. 13, 98-128 (March, 1959). In French.

This review article consists of two parts. The first deals with general concepts: the motion of charged particles in a steady electromagnetic field, the hydrodynamic description of an ion–electron mixture, Maxwell's equations, the generalized Ohm's law, and the characteristic orders of magnitude (especially lengths) in a plasma. The second part deals with some special situations in a "perfect plasma" (one obeying the simplest form of Ohm's law): one-dimensional flow including shock transitions, flow through a tube, stability of flows, laminar boundary layer theory, motion of a solid sphere through a fluid. The discussion of one-dimensional flow appears to be original. There are 16 references. O.Penrose

538.3

9167 STABILITY OF A HOLLOW GAS CONDUCTOR IN A [LONGITUDINAL] MAGNETIC FIELD.
L.M.Kovrizhnykh.
Zh. eksper. teor. Fiz., Vol 37, No. 1(7), 92-4 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 65-6 (Jan., 1960).

538.3

9168 POSSIBLE EQUILIBRIUM CONFIGURATIONS FOR A THIN CIRCULAR PLASMA CONDUCTOR IN A MAGNETIC FIELD. Yu.N.Vandakurov.
Zh. tekh. Fiz., Vol. 29, No. 11, 1312-16 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1207-11 (May, 1960).

Configurations with surface currents (both components) and a volume current are considered.

538.3

9169 AN APPROXIMATE SOLUTION OF A PROBLEM CONCERNING MOTION OF A CONDUCTING PLASMA.
G.A.Skuridin and K.M.Stanyukovich.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1248-51 (Feb. 21, 1960). In Russian.

One-dimensional motion of an imperfectly conducting gas in a

transverse magnetic field is considered. The energy equation is apparently disregarded, and the remaining equations describing the motion are approximately solved by assuming that the magnetic field has the form

$$(\partial/\partial x)\, A(x,t) \exp[i\omega f(x,t)]$$

where

$$A^{-1}\partial^2 A/\partial x^2 \ll \omega^2 (\partial f/\partial x)^2 = \text{const.}\ \kappa$$

and κ is the magnetic viscosity. O.Penrose

538.3

9170 MOTION OF A CONDUCTING PLASMA UNDER THE ACTION OF A PISTON.

G.A.Skuridin and K.P.Stanyukovich.
Dokl. Akad. Nauk. SSSR, Vol. 131, No. 1, 72-4 (March 1, 1960). In Russian.

The results obtained in the preceding abstract are specialized to a case where a uniformly accelerated piston, initially at rest, moves into the gas. The part of the motion which precedes the formation of a strong shock is ignored. O.Penrose

538.3

9171 THE INFLUENCE OF END BOUNDARIES UPON THE ROTATION OF PLASMA IN A MAGNETIC FIELD.

G.V.Gordeev.
Zh. tekh. Fiz., Vol. 29, No. 6, 759-62 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 683-6 (Dec., 1959).

Calculates the angular velocity of, and the radial current density in, a simple conducting fluid placed between two finite coaxial cylindrical conductors placed in a strong uniform magnetic field everywhere parallel to the axis of the conductors. Considers only the balance of the electromagnetic forces with the viscous forces. Assumes a steady state, that the viscosity and conductivity are constant scalar quantities, and that the fluid velocities are zero at all the boundaries. R.S.Pease

538.3

9172 SUPERPOSABILITY OF TWO AXI-SYMMETRIC FLOWS UNDER AXI-SYMMETRIC MAGNETIC FIELDS.

P.Ramamoorthy.
Appl. sci. Res. A, Vol. 9, No. 2-3, 153-6 (1960).

Two theorems are proved, namely (1) an axi-symmetric flow of an infinitely conducting fluid under axi-symmetric magnetic field is always self-additive; (2) two axi-symmetric flows of an infinitely conducting fluid are superposable if the fluid velocity is parallel to the magnetic field in each of the two flows. The conclusion is also reached that an axi-symmetric self-additive system can never be a steady dynamo. T.C.Toye

538.3

9173 THE STABILITY OF NON-DISSIPATIVE COUETTE FLOW IN THE PRESENCE OF AN AXIAL MAGNETIC FIELD. W.H.Reid.
Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 3, 370-3 (March, 1960).

A calculation is made of the magnetic field strength H required to stabilize non-viscous flow between two rotating coaxial cylinders in the "small gap" approximation. The work is based on an exact solution of the non-magnetic problem. H is found to be small for small, and also for large, angular velocity gradients; there is also a critical value for H above which the flow is stable for all angular velocity gradients. R.A.Newing

538.3

9174 STABILITY OF A PLANE POISEUILLE FLOW OF AN IDEALLY CONDUCTING FLUID IN A LONGITUDINAL MAGNETIC FIELD. E.P.Velikhov.
Zh. eksper teor. Fiz., Vol. 36, No. 4, 1192-202 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 848-55 (Oct., 1959).

The necessary and sufficient conditions for the stability of a flow in a magnetic field have been found. It is shown that the critical value of the magnetic field that stabilizes the flow is $0.1\, V_0\sqrt{4\pi\rho}$, where V_0 is the velocity in the centre of the channel and ρ is the fluid density.

538.3

9175 [STATIONARY] CONVECTIVE MOTION OF A CONDUCTING FLUID BETWEEN PARALLEL VERTICAL PLATES IN A MAGNETIC FIELD. S.A.Regirer.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7). 212-16 (July, 1959) In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37,(10), No. 1, 149-52 (Jan., 1960).

An exact solution of the magnetohydrodynamic equations is obtained for the case of a constant vertical temperature gradient. The critical value of Grasshof's number is determined for the case when the temperature of both plates is the same.

538.3

9176 INFLUENCE OF A MAGNETIC FIELD ON THE BOUNDARY LAYER IN A DIFFUSER. A.Gailitis.
Latv. PSR Zinat. Akad. Vestis, No. 12(149), 59-60 (1959). In Russian.

Considers motion of a slightly conducting liquid in a diffuser whose walls are inclined poles of a magnet. Obtains expressions for boundary-layer velocities for the inward and the outward motion of the liquid. J.K.Skwirzynski

538.3

9177 THE DISINTEGRATION OF UNSTABLE SHOCK WAVES IN MAGNETOHYDRODYNAMICS.

G.Ya.Lyubarskii and R.V.Polovin.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1272-8 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 902-6 (Oct., 1959).

The fate of an unstable magnetohydrodynamic shock wave is considered; it is shown that such a wave must necessarily disintegrate into several waves, among which there are fast and slow magneto-acoustic shock and self-simulating (avtomodel'nye) waves, Alfven discontinuities and a contact discontinuity. It is significant that disintegration of the unstable shock wave is accompanied by an increase in the entropy. The disintegration of a stable shock wave is impossible.

538.3 : 534.22

9178 THE EFFECT OF ANISOTROPIC CONDUCTIVITY IN A MAGNETIC FIELD ON THE STRUCTURE OF A SHOCK WAVE IN MAGNETOHYDRODYNAMICS. S.A.Kaplan.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 252-3 (Jan., 1960). In Russian.

Assuming that all parameters change only in the x-direction, the anisotropy of the electrical conductivity causes an appreciable increase of thickness of the wave-fronts of gasmagnetic shock waves, when the wave-front is inclined to the x-axis. The wave-front thickness is proportional to the square of the magnetic field intensity. J.K.Skwirzynski

538.3 : 534.22

9179 THE ATTACHMENT OF SHOCK-FRONTS IN TWO-DIMENSIONAL FLOWS [ROUND A WEDGE]. H.Cabannes.
C.R. Acad. Sci. (Paris), Vol. 250, No. 11, 1968-70 (March 14, 1960). In French.

The conditions of attachment of a shock-front to the point of a wedge are discussed as functions of wedge angle, fluid velocity, magnetic field and ratio of specific heats. H.N.V.Temperley

538.3 : 550.3

9180 THE TRANSMISSION OF GEOMAGNETIC DISTURBANCES THROUGH THE ATMOSPHERE AND INTERPLANETARY SPACE. J.H.Piddington.
Geophys. J., Vol. 2, No. 3, 173-89 (Sept., 1959).

The theory of the propagation of slowly varying electromagnetic disturbances through a partially ionized gas is developed and applied to the earth's atmosphere and interplanetary space. The medium must be regarded as two separate, co-existing gases, an electron–ion plasma and neutral atoms which move to some extent independently. Quantitative results are given for a model atmosphere out to several earth radii: (1) up to a few hundred kilometres the medium behaves, for waves of all periods between 1 and 10^4s, as a rigid conductor and as a dispersive medium; (2) above about 10^3 km the disturbances travel as hydromagnetic waves in the ion plasma alone. Losses are small in this region but transmission is likely to be complicated by anisotropic transmission of the O wave and by refraction and partial reflection; (3) the currents responsible for all observed geomagnetic disturbances must flow at levels below about 1000 km; (4) the problem of the penetration of solar gas into the earth's field is discussed; (5) some earlier theories of the main phase of an SC storm are discussed and an alternative suggested whereby some lines of force of the earth's field are carried away along the sun–earth line; (6) some properties of micropulsations

are explained in terms of the transmission of hydromagnetic waves; (7) the "effective" conductivity (σ_e) of the atmosphere out to several earth radii has its maximum about 100 km, above which it rapidly falls to about 10^{-18} e.m.u. or less and does not rise again.

538.3 : 550.3

MAGNETIC EFFECTS RESULTING FROM TWO HIGH-ALTITUDE NUCLEAR EXPLOSIONS. See Abstr. 4770

536.3 : 551.5

9181 IONOSPHERIC HEATING BY HYDROMAGNETIC WAVES. A.J.Dessler.
J. geophys. Res., Vol. 64, No. 4, 397-401 (April, 1959).

The rate of energy dissipation per unit volume is investigated for hydromagnetic waves travelling downward through the ionosphere. A calculation of the heating rate is made, based on assumptions as to the amplitude and Fourier spectrum of the hydromagnetic waves. It is argued in a general way that the peak heating rate due to hydromagnetic waves occurs near 175 kilometers. The results, which are strongly dependent on the assumed values for the amplitude and Fourier spectrum of the hydromagnetic waves, indicate that hydromagnetic heating is normally not important in determining the temperature of the F-region. However, during a magnetic storm, the hydromagnetic heating may become the dominant source of heat in the F-region. The suggestion is made that the observed lifting of the F-region during a magnetic storm is due to an increased heating rate caused by the storm-generated hydromagnetic activity. It is shown that it is not possible to account for the main phase of a magnetic storm by ionospheric heating.

538.3 : 551.5

MAGNETO-HYDRODYNAMIC WAVES IN THE IONOSPHERE. See Abstr. 8370

538.3 : 551.5

GLOBAL HYDROMAGNETIC WAVE DUCTS IN THE EXOSPHERE. See Abstr. 8369

538.3 : 621.039

9182 EXPERIMENTAL MAGNETOHYDRODYNAMIC POWER GENERATOR. R.J.Rosa.
J. appl. Phys., Vol. 31, No. 4, 735-6 (April, 1960).

Electric power is generated by drawing current from a plasma jet moving perpendicular to a 14 000 G magnetic field. A graph shows the voltage, power output, and upstream stagnation pressure as functions of the current drawn. Voltage and pressure vary linearly with current, in agreement with theory. The efficiency of this type of power generation is discussed briefly. O.Penrose

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56

9183 LOW-FREQUENCY EDDY-CURRENT LOSSES IN A CYLINDRICAL ROD. O.Beaufays.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 9, 870-5 (1959). In French.

A general formula, giving the eddy current loss in cylindrical rods of arbitrary section, was derived. It is found that the loss is independent of the permeability of the material forming the cylinder. S.A.Ahern

538.56 : 621.375.9

9184 OPERATION OF MAGNETIC FILM PARAMETRONS IN THE 100 TO 500 Mc REGIONS.
A.V.Pohm, A.A.Read, R.M.Stewart, Jr and R.F.Schauer.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 119S-200S (May, 1960).

An analysis of the behaviour of thin magnetic films of Permalloy when used as time-variable inductors has been made in terms of a modified Landau-Lifshitz equation. These results show that parametrons using time-variable magnetic-film inductors can be made to operate at reasonable power levels with large gains per cycle at oscillating frequencies in the 100 to 500 Mc/s region. A way of fabricating magnetic film parametrons with strip line techniques is shown. Calculations indicate that units with dissipations in the 10 mW range are feasible with existing techniques for operation in the 100 to 500 Mc/s region. Ways of advantageously using capacitive coupling between parametron units is indicated in which the two new subharmonic states of a magnetic film parametron created by a bias reversal are used.

538.56 : 621.373.421.11

9185 PARAMETRIC EXCITATION OF HARMONIC OSCILLATIONS IN A LINEAR OSCILLATING CIRCUIT WHOSE PARAMETERS CHANGE WITH TIME IN NONPERIODIC FASHION. P.G.Gorodetskii.
Zh. tekh. Fiz., Vol. 29, No. 5, 580-3 (May, 1959). In Russian. English translation of article in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 517-20 (Nov., 1959).

It is shown that it is possible for harmonic oscillations of the current to be produced in the circuit.

538.56

9186 SPONTANEOUS EMISSION FROM AN INVERTED SPIN SYSTEM. A.Yariv.
J. appl. Phys., Vol. 31, No. 4, 740-1 (April, 1960).

The results of calculations made in an attempt to explain the origin of the observed modulation effects in two-level maser experiments (Abstr. 2653 of 1958 and 5139 of 1958) are reported. In a spontaneously oscillating spin system any transverse magnetization which couples power out of the spin system is due to the presence of a transverse r.f. field, which is in turn induced by the transverse magnetization. Any consideration of the dynamics of the spin system or the build-up of the radiation field must consequently treat the two systems simultaneously. This analysis uses a model first formulated by Bloembergen and Pound (Abstr. 8532 of 1954), but the problem is inherently non-linear and hence more complex because the simplifying assumption M_z = constant cannot be made. The results have been compared with experimental values, and good agreement has been obtained for the decay curve forming the locus of r.f. power output peaks; but there is a significant difference between experiment and theory in the intervals between power output peaks. S.A.Ahern

538.56 : 539.2 : 538.27 : 621.374.4

9187 HARMONIC GENERATION IN A FERRIMAGNETIC DISK. G.E.Bennett.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 97S-99S (May, 1960).

A small ferrimagnetic ellipsoid biased to resonance with an arbitrarily direct d.c. magnetic field will, in general, produce second harmonic components of the magnetization vector in both longitudinal and transverse planes — defined relative to the internal d.c. field. For an ellipsoid of revolution the theoretical dependence upon the direction of magnetization of these and higher harmonic components is reported. S-band doubling experiments performed on a thin polycrystalline YIG disk mounted in rectangular waveguide confirm the theoretical dependence of the two doubling processes and the expected linear dependence of conversion efficiency on input power. Transverse third and fourth harmonics which were respectively cubic and quartic functions of the input power have also been detected.

538.56 : 621.373.421.14

9188 THEORY AND APPLICATION OF DIPOLAR FERRITE MODES. W.H.Steier and P.D.Coleman.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 99S-100S (May, 1960).

Experimental verification at X and K band of theoretical calculations on the magnetodynamic resonant modes of a ferrite rod between parallel conducting sheets is reported. Critically coupled mode Q's as high as 1100 have been measured. The characteristic equation includes propagation effects and dipolar coupling between electron spins. Mode charts for the symmetric modes are displayed for biasing fields from 3 to 20 kOe and for frequencies from 4 to 50 kMc/s for both Ferramic R-1 and polycrystalline YIG. The modes have been experimentally observed in the ranges of 10 and 20 kMc/s. Comparison of theoretical and experimental data is made in these bands for both R-1 and YIG. The variation of the observed loaded Q with biasing magnetic field is described. The advantages that these modes possess over the magnetostatic modes for microwave engineering applications are pointed out. These include: (a) relatively high Q; (b) ability to critically couple; and (c) sample size is comparable to the wavelength.

538.56 : 539.12

9189 CHERENKOV RADIATION OF DIPOLES MOVING IN A CHANNEL IN A DIELECTRIC. L.S.Bogdankevich.
Zh. tekh. Fiz., Vol. 29, No. 9, 1086-9 (Sept., 1959). In Russian.

English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 992-5 (March, 1960).

Computes the field and radiation of magnetic and electric dipoles which move along the axis of a channel in a dense medium. It is shown that if the radius (a) of the channel satisfies the condition $a \ll \lambda$, the radiation of an electric dipole which moves in the direction perpendicular to its axis is increased by a factor of $4\epsilon^2/(\epsilon + 1)^2$, as compared with the radiation in a continuous medium.

538.56

9190 THE DOPPLER EFFECT IN AN ANISOTROPIC AND GYROTROPIC MEDIUM. K.A.Barsukov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1485-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1052-6 (Nov., 1959).

The Doppler effect is treated for motion of an oscillator along the axis of a gyrotropic anisotropic crystal. General formulae for the energy of the radiation are obtained; these can be used, in particular, to obtain formulae for the Cherenkov radiation of a charge and of a dipole. A number of properties of the radiation that are peculiar to an anisotropic, gyrotropic medium are investigated.

538.56

9191 MAGNETIC FIELD STABILIZATION BY A NUCLEAR MAGNETIC RESONANCE MASER. H.Hahn.

C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2335-7 (March 28, 1960). In French.

The circuit for the stabilizer is described and analysed. The magnetic field stability obtained is $\pm 6 \times 10^{-7}$, equivalent to a long-term stability of $\pm 1 \times 10^{-8}$. S.A.Ahern

538.56

9192 HARMONIC SPIN COUPLING IN RUBY. J.E.Geusic.

Phys. Rev., Vol. 118, No. 1, 129-30 (April 1, 1960).

A new mode of maser pumping which makes use of harmonic spin coupling in ruby has been demonstrated. In addition, higher-order harmonic spin coupling effects in ruby have been found experimentally.

538.56

9193 A MASER AT 1420 MHz. B.Bölger, J.Ubbink and B.J.Robinson.

Physica, Vol. 24, Supplement, S164 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Tests are carried out to develop a three-level maser to amplify the weak radiation emitted by interstellar hydrogen at 1420 Mc/s. Amplification at 1423 Mc/s has been obtained with a cavity containing a $K_3Cr(CN)_6$ crystal using a pumping frequency of 3850 Mc/s. Coinciding resonances at both frequencies for transitions between the lower three energy levels are found for four magnetic field strengths in directions near the a-axis of the crystal. Stimulated emission has been obtained between the lowest pair of levels for field strengths of 520 Oe and 1300 Oe; for the next higher pair of levels it was only possible to reach infinite spin temperatures. Relaxation times have been measured by a pulse method up to 20°K. Other crystals are being investigated.

538.56 : 621.375.59

9194 CW MILLIMETER WAVE MASER USING Fe^{3+} IN TiO_2. S.Foner and L.R.Momo.

J. appl. Phys., Vol. 31, No. 4, 742-3 (April, 1960).

A 3-level maser using Fe^{3+} ions in titania was operated at 26-39 kMc/s. The pump oscillator was a narrow-band 4 mm. klystron and the large signal band was obtained by varying the magnitude and orientation of the magnetic field. At 4.2°K the gain-bandwidth product was 10-40 Mc/s. The advantages of using a material with a high dielectric constant and high zero field splitting in the millimetre band are emphasised. D.Walsh

538.56 : 621.375.9

9195 PULSED FIELD MILLIMETER WAVE MASERS. L.R.Momo, R.A.Myers and S.Foner.

J. appl. Phys., Vol. 31, No. 2, 443 (Feb., 1960).

Ruby, for use as a three-level maser, is saturated with 12.7 kMc/s. The pump source is gated off within 10 microsec. of the start of a high magnetic field pulse up to 30 kOe. Maser action was observed at 14 different emission frequencies up to 70 kMc/s. A power output of 0.025 W was obtained at 40 kMc/s. The data show that the field dependence of relaxation time in ruby is small. H.Motz

538.56 : 621.375.9

9196 OPERATION OF A CHROMIUM DOPED TITANIA MASER. H.J.Gerritsen and H.R.Lewis.

J. appl. Phys., Vol. 31, No. 3, 608 (March, 1960).

A maser using Cr^{3+} ions in titania was operated in the 10 kMc/s band using a 35 kMc/s pump, and at 22.3 kMc/s with a pump frequency of 49.9 kMc/s. The gain bandwidth product at X band and 4.2°K was 25 Mc/s. Because of its high zero field splitting, this material may have advantages over ruby at millimetre wavelengths. D.Walsh

538.56 : 621.375.9

9197 EFFECT OF NUCLEAR POLARIZATION ON THE BEHAVIOUR OF SOLID STATE MASERS. G.Makhov, L.G.Cross, R.W.Terhune and J.Lambe.

J. appl. Phys., Vol. 31, No. 5, 936-8 (May, 1960).

It was observed that the application of an r.f. field near the frequency of quadrupole resonance of the aluminium nuclei in ruby, produced a marked change in the electron-spin resonant absorption under saturation conditions. Application of 10-100 mW of r.f. power at frequencies between 0.5 and 20 Mc/s changed the mode of operation of an X-band maser from the normal c.w. mode to a relaxation mode. The applied r.f. decreased the negative magnetic Q by about 20% and the result is similar to that which might be obtained with added pumping. G.D.Sims

538.56 : 621.375.9 : 621.317.34

9198 NOISE TEMPERATURE MEASUREMENT ON A TRAVELING-WAVE MASER PREAMPLIFIER. R.W.DeGrasse and H.E.D.Scovil.

J. appl. Phys., Vol. 31, No. 2, 443-4 (Feb., 1960).

A liquid nitrogen input load and one at room temperature could alternatively be connected to a T.W.M., by means of a wave-guide switch. The output was connected through an attenuator to a T.W.-tube amplifier. Adjusting the attenuator so that the power output was read in the two cases, the amplifier noise was eliminated. A noise temperature of 10.7 ± 2.28°K was measured. Noise from the input cable contributed 9 ± 1°K. A second experiment is planned which will eliminate cable loss. H.Motz

538.56 : 539.19 : 621.375.9

FORMING MOLECULAR BEAMS FOR USE IN AMMONIA MASERS. See Abstr. 7826

538.56 : 621.375.9

9199 VALIDITY OF THE THEORY OF DOUBLE STREAM AMPLIFICATION. D.T.Swift-Hook.

Phys. Rev., Vol. 118, No. 1, 1-5 (April 1, 1960).

Misunderstandings have been recently arisen (Abstr. 3038 of 1956; 7111 of 1959) concerning the validity of the original analysis of the interaction between interpenetrating ion streams to give double stream amplification. It is shown that none of the modes of propagation upon which criticism has been centered corresponds to that of double stream amplification. A direct theoretical proof of the validity of the theory is given.

538.56 : 621.375.9

9200 THEORY OF A NEGATIVE-RESISTANCE TRANSMISSION LINE AMPLIFIER WITH DISTRIBUTED NOISE GENERATORS. K.K.N.Chang.

J. appl. Phys., Vol. 31, No. 5, 871-5 (May, 1960).

A transmission line with distributed positive and negative resistances as well as with distributed noise generators is treated. Gain and noise factor are derived as a function of boundary conditions, matching conditions and distributed noise. It is found that low-noise amplification can be achieved on such a line provided the line is characterized by high gain per unit length, high total gain, good matching, and low distributed noise. A distortionless active line for such low-noise amplifiers appears attractive.

538.56 : 621.375.9

9201 DOUBLE PUMP DEGENERATE FERRITE AMPLIFIER. P.Gottlieb.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 172S-173S (May, 1960).

A theoretical discussion of the possibilities for the design of a parametric amplifier using a pump frequency lower than the signal frequency (but higher than one half the signal frequency) is given. In particular, a detailed mechanism for the operation of a ferrite amplifier with such properties is described. The amplifier operation is similar to that used by Bloom and Chang [Abstr. 2606B of 1958; J. appl. Phys., Vol. 29, No. 3, 594 (March, 1958)] for a diode

amplifier with cubic nonlinearity. Hogan, Jepsen and Vartanian have proposed a ferrite device to serve the same purpose as the present amplifier; however, their scheme is quite different, and a detailed comparison is given here. The main feature of the present amplifier is a doubling of the pump frequency to obtain an effective pump frequency which is larger than the signal frequency. The whole amplifier requires four resonances: the pump frequency, twice the pump frequency, the signal frequency, and twice pump minus signal (idle). The most efficient assignment of the modes uses cavity resonances for the signal and pump, and then uses either cavity or ferrite resonances for the other frequencies. Since the pump doubling is a result of nonlinear mixing, the efficiency of doubling will be greater for larger pump fields. This is limited in practice by the onset of saturation in the ferrite. For pump fields close to saturation the required pump field is calculated to be five to ten times larger than that required to produce the same gain in an ordinary three-resonance amplifier.

538.56

9202 EXPERIMENTAL DETERMINATION OF POWER IN THE SUB-MILLIMETER RANGE FROM A MAGNETIC UNDULATOR. I.A.Grishaev, V.I.Kolosov, V.I.Myakota, V.I.Beloglasov and B.V.Yakimov.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 1, 61-3 (March, 1960). In Russian.

The radiation from a 17 MeV electron beam passing through a magnetic undulator with a period of 10 cm was examined. A discrete spectrum was found by means of a diffraction grating spectrometer. Radiation in two bands, one ranging from 50 to 67μ and the other ranging from 100 to 250μ was found. The power was measured by means of a thermopile. The background, which was considerable, was eliminated by observing for two values of the undulator field and assuming that the power ratio is the square of the ratio of the magnetic fields. With a beam of 1-4 μA, the power output calculated from the measurements was from 3.3×10^{-9}W to 8.5×10^{-9}W.

H.Motz

538.56

9203 THE MAGNETIC FLASH OF THE NUCLEAR TEST OF 13th FEBRUARY 1960 AT REGGANE. J.Delloue.
C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2536-7 (April 4, 1960). In French.

An electromagnetic signal orginating from the nuclear explosion was recorded at a distance of 2500 km, and the field strength shown to be 0.1 V/m.

J.Dutton

538.56

9204 HIGH-SPEED FERRITE ROTATING HALF-WAVE PLATE. F.S.Coale.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 170S-171S (May, 1960).

A novel approach for constructing a ferrite rotating half-wave plate for use as a frequency translator or an amplitude modulated single sideband modulator is presented. This is accomplished through the use of a four-wire balanced transmission line for generating both the rotating microwave fields and the rotating low frequency magnetizing fields. The principles of operation of this type modulator should allow modulation frequencies in excess of 10 Mc/s. Eddy current losses, which usually limit the high frequency modulation of ferrite single sideband modulators are minimized by passing high currents down the wires of the four-wire transmission line to generate the magnetizing field at the modulation frequency. The magnetic fields which are developed are sufficient to cause 180° relative phase shift between the orthogonal microwave components. The magnetizing fields are phased in quadrature so that a rotating magnetic field is developed whose speed of rotation is determined by the frequency of the magnetizing field. The resultant microwave frequency shift is twice the frequency of the magnetizing field due to the inherent action of the half-wave plate. If the amplitude of the magnetizing field is varied, then the relative phase shift produced by magnetic birefringence is no longer 180° but may be some value between 0° and 180°. This in effect produces a frequency translated signal whose amplitude varies with the magnitude of the magnetizing field.

538.56

9205 GROWTH OF ELECTROMAGNETIC WAVES IN INTERPENETRATING INFINITE MOVING MEDIA.
G.G.Getmantsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 843-6 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 600-2 (March, 1960).

An investigation is made of the propagation of monochromatic plane waves. Equations are obtained for the refractive index; these equations are used to investigate the stability of the propagating waves. The time growth (damping) factor for the wave is found for the case of motion of a plasma through a dispersionless dielectric.

538.56

9206 SYMMETRIC ELECTRIC OSCILLATION OF AN IDEALLY CONDUCTING HOLLOW CYLINDER OF FINITE LENGTH. P.L.Kapitsa, V.A.Fok and L.A.Vainshtein.
Zh. tekh. Fiz., Vol. 29, No. 10, 1188-1205 (Oct., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 10, 1088-1105 (April, 1960).

Considers the electromagnetic oscillations in which the current flows along the cylinder and is distributed uniformly over its periphery. An exact intrgral equation is formulated to relate the vector potential at the surface of the cylinder with the current for any method of excitation of the oscillations; techniques are derived for changing the integral equation to an infinite system of linear equations which relate the coefficient in the current expansion and the vector potential in trigonometric series. Formulae are given for computing the matrix elements of each of these systems and the possibility of solving by an iteration method is indicated. A comparison is made between the proposed method of calculation and the theory of thin aerial radiators.

538.56

9207 DISTRIBUTION OF CURRENT DENSITIES ON THE EDGES OF AN IDEALLY CONDUCTING RECTANGULAR WEDGE PLACED IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE. N.N.Lebedev and I.P.Skal'skaya.
Zh. tekh. Fiz., Vol. 29, No. 7, 928-30 (July, 1959). In Russian. English Translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 7, 841-4 (Jan., 1960).

538.56

9208 DIFFRACTION OF [PLANE] ELECTROMAGNETIC WAVES BY A CIRCULAR APERTURE IN AN IDEALLY CONDUCTING PLANE [FOR NORMAL INCIDENCE].
G.A.Grinberg and Yu.V.Pimenov.
Zh. tekh. Fiz., Vol. 29, No. 10, 1206-11 (Oct., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 10, 1106-11 (April, 1960).

A direct solution is given for the integral equations in the approximations in which $ka = \gamma$ is much larger than unity (k is the wave-number and a is the radius of the aperture). Numerical calculations indicate that for small values of γ, the solution gives results which are approximately the same as the exact solution.

538.56

9209 DIFFRACTION OF ELECTROMAGNETIC WAVES ON A FINITE PARABOLOID (AXIALLY SYMMETRIC FIELDS).
Yu.N.Kuz'min.
Zh. tekh. Fiz., Vol. 29, No. 11, 1304-11 (Nov., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 11, 1199-206 (May, 1960).

Considers a thin, ideally conducting, paraboloidal segment. Two kinds of axially symmetric excitation field are investigated. In both cases the problem is reduced to a series of successive electrostatic problems and solved by expansion in powers of the parameter $\delta = kR$.

538.56 : 534.26

THE DIFFRACTION AND REFRACTION OF E.M. PULSES.
See Abstr. 8752

538.56 : 535.8

DIFFRACTION IN MICROWAVE OPTICAL SYSTEMS.
See Abstr. 8786.

538.56 : 537.56

THE REFLECTION OF AN ELECTROMAGNETIC WAVE FROM A PLASMA MOVING THROUGH A DIELECTRIC IN A CONSTANT MAGNETIC FIELD. See Abstr. 9057

538.56

9210 RAMAN SCATTERING OF ELECTROMAGNETIC WAVES IN FERROMAGNETIC DIELECTRICS [FERRITES].
F.G.Bass and M.I.Kaganov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1390-3 (Nov., 1959). In Russian.

Raman scattering of electromagnetic waves by oscillations of the magnetic moment is predicted. The extinction coefficient for the scattered radiation is calculated.

538.56 : 621.372.829

9211 DISPERSIVE PROPERTIES OF A COAXIAL SPIRAL LINE PLACED IN A MAGNETO-DIELECTRIC MEDIUM. V.P.Shestopalov and L.I.Spol'nik.
Zh. tekh. Fiz., Vol. 30, No. 1, 3-14 (Jan., 1960). In Russian.

Dispersion curves are computed for both slow and fast waves which can be propagated in a coaxial spiral line placed in such a medium. The forbidden regions of propagation are established and the results are fully illustrated. J.K.Skwirzynski

538.56

9212 THE PROPAGATION OF SURFACE ELECTROMAGNETIC WAVES ALONG A MULTI-WIRE SYSTEM. N.A.Armand.
Zh. tekh. Fiz., Vol. 29, No. 1, 107-19 (Jan., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 1, 93-104 (Jan., 1959).

This investigation includes the case of wires thinly coated with dielectric. The dispersion equation which gives the wave numbers of the surface waves propagated is obtained in the form of a determinant of infinite order. Assumptions are made to simplify this (e.g. spacing much greater than wire diameter) and the specific case of two wires is given. The analogy between these wave solutions and the behaviour of coupled tuned circuits is remarked. D.Walsh

538.56 : 621.372.8.09

9213 BOUNDS ON THE ELEMENTS OF THE EQUIVALENT NETWORK FOR SCATTERING IN WAVEGUIDES. I. THEORY. L.Spruch and R.Bartram.
J. appl. Phys., Vol. 31, No. 5, 905-13 (May, 1960).

For a few particular waveguide problems, standard variational expressions have previously been shown to be upper or lower bounds on the quantities of interest. However, bounds have not previously been obtained for any truly three-dimensional problem, that is, where the fields cannot be derived from a single scalar potential. An example is a three-dimensional obstacle which contacts only one waveguide surface. As one consequence, no straightforward procedure exists for improving the approximations. Recently, Kato (Abstr. 778 of 1952) devised a rather general method for bounding the cotangent of the phase shift for a given angular momentum in a quantum mechanical central potential scattering problem. This method should be applicable whenever a system can be analysed in terms of uncoupled standing waves each characterizable by one real phase-shift. The method is here adapted to waveguides, including truly three-dimensional problems. The obstacle must be symmetric about a plane perpendicular to the waveguide axis, with certain exceptions only one mode should propagate, and the system should be lossless. Analysis is then possible in terms of η_s and η_0, the real uncoupled phase-shifts associated with the even and odd standing waves, respectively. The bounds obtained on $\cot\eta_s$ and $\cot\eta_0$ determine bounds on the equivalent network elements.

538.56 : 621.372.8.09

9214 BOUNDS ON THE ELEMENTS OF THE EQUIVALENT NETWORK FOR SCATTERING IN WAVEGUIDES. II. APPLICATION TO DIELECTRIC OBSTACLES. R.Bartram and L.Spruch.
J. appl. Phys., Vol. 31, No. 5, 913-17 (May, 1960).

The theory developed in the preceding abstract for obtaining rigorous bounds on $\cot\eta$, where η is the phase-shift, is applied to scattering by dielectric obstacles in rectangular waveguides. For the obstacles considered here, bounds are also obtained on the phase shifts directly and on the elements of the equivalent-T network. The exact solution for a dielectric slab of finite length, which extends to the conducting boundaries of the waveguide and completely encloses the obstacle, is introduced as a convenient trial function. The permittivity of the slab is retained as a parameter which is varied to improve the bounds. In the expression for the bounds on $\cot\eta_s$ and $\cot\eta_0$, the particular obstacle configuration appears only in certain integrals of relatively simple form. Numerical results are obtained for large and small obstacles of various shapes, including some truly three-dimensional cases. The upper and lower bounds on the phase-shifts and on the elements of the equivalent circuit are found to be quite close to one another. In one case, the bounds obtained by using the simple trial function are compared with the bounds obtained by using the trial function which generates the Schwinger integral variational principle.

538.56 : 621.372.823

9215 PROPAGATION OF QUASI-CIRCULAR ELECTROMAGNETIC WAVES IN A WAVEGUIDE OF CROSS-LIKE CROSS-SECTION. V.M.Sedykh and A.F.Zorkin.
Zh. tekh. Fiz., Vol. 30, No. 2, 159-64 (Feb., 1960). In Russian.

The field equations are used to obtain relations for the determination of critical frequencies of a quasi-circular electromagnetic wave as well as a wave transformed from the E_{11} mode, in a circular guide. The propagation constant is calculated and plotted against frequency when such waves are transmitted in a waveguide of cross-like cross-section. J.K.Skwirzynski

538.56 : 621.372.829

9216 DETERMINATION OF THE DISPERSION RELATION FOR WAVEGUIDES WITH HELICES.
A.K.Berezin, P.M.Zeidlits, A.M.Nekrashevich and G.A.Silenok.
Zh. tekh. Fiz., Vol. 29, No. 7 808-14 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol, 4, No. 7, 730-5 (Jan., 1960).

Experimental measurements of the dispersion relation are described and the results are compared with theory. The dependence of the dispersion on the thickness of the helix was investigated. The measurements were carried out between 150 and 800 Mc/s. The relative error in the measurements was 1.5% at the high frequencies, and up to 4.5% at the low frequencies.

538.56 : 621.372.829

9217 EXPERIMENTAL INVESTIGATION OF THE DISPERSION RELATION OF A WAVEGUIDE WITH A CROSS-WOUND HELIX.
A.K.Berezin, P.M.Zeidlits, A.M.Nekrashevich and I.P.Skoblik.
Zh. tekh. Fiz., Vol. 29, No. 7, 808-14 (July, 1959). In Russian.
English translation in: Soviet Physics—Technical Physic (New York), Vol. 4, No. 7, 730-5 (Jan., 1960).

Reports the use of the perturbation method for investigating the dispersion. It was established experimentally that in a slow-wave structure of this kind four waves are propagated; each wave is characterized by a different phase velocity. Measurements were made of the dispersion of three of these waves as functions of guide geometry and of frequency in the range 150-800 Mc/s.

538.56 : 621.372.829

9218 EXPERIMENTAL INVESTIGATION OF THE EFFICIENCY OF A HELIX WAVEGUIDE.
G.A.Silenok, A.K.Berezin, P.M.Zeidlits and A.M.Nekrashevich.
Zh. tekh. Fiz., Vol. 29, No. 8, 946-53 (Aug., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 861-7 (Feb., 1960).

The frequency dependence of the efficiency was determined in the range 150-800 Mc/s. The results of measurements are in agreement with theoretical calculations for the case in which the helix is assumed to be an infinitely thin cylinder which conducts only in the direction of the windings (sheath model). An investigation was also made of the effect of the helix wire thickness on system efficiency. The experimental method and equipment are described.

538.56 : 621.372.831.1

9219 TETRAHEDRAL JUNCTION. J.A.Weiss.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 168S-169S (May, 1960).

The term tetrahedral junction refers to a class of waveguide junctions having the symmetry properties of a tetrahedron, and loaded by a ferrite rod magnetized axially. The structure possesses a combination of properties which make it suitable as a gyrator or switch and, with appropriate modifications, as an isolator or circulator. It exhibits characteristically low dissipative loss, high mechanical symmetry, and moderate band width. A first attempt to construct a simple theoretical model has yielded a correlation with the most conspicuous observed properties of the junction.

538.56 : 621.372.852.3

9220 MULTIMODE PROPAGATION IN GYROMAGNETIC RODS AND ITS APPLICATION TO TRAVELING-WAVE DEVICES. J.E.Tompkins, F.Reggia and L.Joseph.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 176S-177S (May, 1960).

Summarises the results of exact calculations of the propagation constants in longitudinally-magnetized gyromagnetic rods. Specifically described are: (a) the mode behaviour for a lossless rod in cylindrical waveguide as a function of rod diameter in the low-field

region; (b) a comparison of the calculations with experimental results obtained with a magnetized ferrite rod in rectangular waveguide showing probable negative circular polarization of the field when concentrated within the rod; (c) a brief summary of the calculations of the propagation in rods at high d.c.fields; and (d) a new broadband microwave absorption switch having constant electrical characteristics over a bandwidth of 3000 Mc/s at X band.

538.56

9221 THE REFLEXION OF RADIO WAVES FROM A STRATIFIED IONOSPHERE MODIFIED BY WEAK IRREGULARITIES. II. M.L.V.Pitteway.

Proc. Roy. Soc. A, Vol. 254, 86-100 (Jan. 19, 1960).

The results of earlier work (Abstr. 7232 of 1960) are applied to an ionosphere containing weak random irregularities, specified only statistically. It is supposed that the shape of the irregularities is described by a Gaussian autocorrelation function, and that their intensity varies in a known way with height. Possibilities of obtaining slow and rapid fading characteristics from forward and back scatter by the irregularities are considered briefly. Certain conclusions of the earlier paper, concerning the importance of scattering by irregularities near the reflection level, are modified. A mechanism for explaining the occurence of "spread F" signals is suggested.

538.56 : 621.391.812.63

9222 IGY OBSERVATIONS OF F-LAYER SCATTER IN THE FAR EAST.

R.Bateman, J.W.Finney, E.K.Smith, L.H.Tveten and J.M.Watts.

J. geophys. Res., Vol. 64, No. 4, 403-5 (April, 1959).

Peculiar signal enhancements observed during transmission at 36 to 50 Mc/s between the Philippines and Okinawa appear to represent F-layer scatter. These signals are observed nightly for period of several hours during the months of September and October. Pulse tests indicate F-layer heights for these signals. Considerable pulse broadening is observed and the signals generally arrive from somewhat off the great circle path.

538.56 : 551.5 : 621.391.822

EFFECTS OF HIGH-ALTITUDE NUCLEAR EXPLOSIONS ON RADIO NOISE. See Abstr. 8430

Radiofrequency Spectroscopy Techniques

538.56

9223 DIRECT MEASUREMENT OF LONG SPIN-LATTICE RELAXATION TIMES. L.O.Bowen.

Proc. Phys. Soc., Vol. 75, Pt 3, 450-52 (March, 1960).

A modification of the adiabatic rapid passage technique for the measurement of nuclear spin-lattice relaxation times T_1 is described, suitable for times T_1 long compared with the period of the magnetic field modulation. Values of T_1 from 0.5 sec to several minutes have been measured with an estimated accuracy of ±5%, but are not quoted. E.F.W.Seymour

538.56

9224 FIELD-SWEPT CARR–PURCELL EXPERIMENT. A.Sher and R.E.Norberg.

Rev. sci. Instrum., Vol. 31, No. 5, 508-10 (May, 1960).

It is demonstrated that a linear sweep of the magnetic field reduces the requirement for precise 180° rotations in a Carr–Purcell spin echo experiment. (Abstr. 6788 of 1954).

538.56

9225 BROADBAND MILLIMETER WAVE PARAMAGNETIC RESONANCE SPECTROMETER. J.B.Mock.

Rev. sci. Instrum., Vol. 31, No. 5, 551-5 (May, 1960).

A flexible magnetic resonance spectrometer is described. Its transmission type microwave structure can be used between 50 and 150 kMc/s. A modified Varian magnet gives a field of 28 000 G, homogeneous to 3 G over a typical sample area. A Dewar vessel fits into the ½ in. magnet gap and permits cooling of the sample below the λ point of helium. The millimeter waves are generated by backward wave oscillators, and harmonic conversion is used for the frequency measurement and control. A modification of the spectrometer makes possible the direct measurement of line width and frequency of zero-field lines.

538.56 : 539.2 : 538.27

9226 PULSED NUCLEAR RESONANCE SPECTROSCOPY. M.Emshwiller, E.L.Hahn and D.Kaplan.

Phys. Rev., Vol. 118, No. 2, 414-24 (April 15, 1960).

A technique for the detection of weak nuclear resonance interactions in solids is carried out by a pulsed method which obtains nuclear double resonance. The resonance of the unknown species to be detected does not require a Boltzmann population difference in spin orientation, but must have a sufficient dipole–dipole interaction with a second spin species. At resonance, a single 180° pulse reorients the unknown spins at the time of the 180° pulse in the 90°-180° pulse sequence necessary to obtain the observed spin-echo signal of the second species. A reduction of the spin-echo signal signifies double resonance due to changes in local dipolar fields, coupled to the observed spins, which scrambles their precessional phases. Nuclear quadrupole coupling interactions of K, Cs and Rb isotopes are measured in the chlorates of these ions, where the Cl^{35} nucleus provides the observed nuclear quadrupole echo. An analysis is presented for the case of low concentration of unknown spin species. Double quantum transitions and special properties of nuclear quadrupole spectra are observed.

NUCLEAR AND ATOMIC PHYSICS

539

9227 LOW-ENERGY NUCLEAR PHYSICS. E.Bretscher.

Nature (London), Vol. 186, 58 (April 2, 1960).

Review of a report on the following conference: Proceedings of the International Conference on Nuclear Physics: Low-Energy Nuclear Interactions and Nuclear Structure; Paris 7-12th July, 1958. Presented by Mme P.Gugenberger. The volume is essentially a verbatim account of the conference including all discussions. The various sections deal with the following topics: (a) elastic scattering of neutrons; charged particles; (b) scattering and nuclear forces; scattering by electrons; analysis of p–p scattering below 40 MeV; (c) direct interaction; theory; deuteron stripping; (d) heavy ions; (e) photonuclear reactions; (f) the independent particle model and its connection with the collective model; (g) the collective model; Coulomb excitation; (h) structure of nuclear matter; (i) weak interactions; theory and experimental results. The Russian papers are not included due to delay in receipt.

APPARATUS . PARTICLE DETECTORS

539.1.07

9228 CHLORINE FILLED OZONISER AS A COUNTER. R.G.Anikhindi and A.P.Saxena.

Curr. Sci., Vol. 29, No. 3, 90-1 (March, 1960).

Briefly describes the use of a chlorine filled (12 mm Hg pressure at 38° C) Siemens ozonizer tube as a counter. J.D.Craggs

539.1.07

9229 CHANGE OF THE SPECTRAL YIELD CURVE OF COUNTER-TUBE CATHODES DURING OPERATION. A.Eckardt and V.Heinecke.

Exper. Tech. der Phys., Vol. 7, No. 6, 268-71 (1959). In German.

Experimental results are given to show that the change, during operation, of the spectral yield curves for cathodes of Pt, Au, W, Ag and Cr is of a different sort from that for cathodes of Al and Cd. It is postulated that the change for Pt etc. is due to the formation of an electrical double-layer only, while that for Al and Cd is due to the formation of "sticking places" in addition to the double-layer. J.Dutton

539.1.07

9230 AN INEXPENSIVE CASTLE AND SAMPLE HOLDER FOR RADIOACTIVE COUNTING. H.Boroughs.
Nature (London), Vol. 186, 145-6 (April 9, 1960).

Describes the construction of a castle-assembly for a G.M. counter which is comparatively cheap. Provision is made for sample holders to be placed at different distances from the counter and back-scatterers are easily held in place. Background at an altitude of 600 m was about 70 counts/min (window thickness 1.4 mg cm^{-2}). R.H.Thomas

539.1.07 : 539.12

MEASUREMENTS OF LOW ENERGY BETA-RAYS; THE CONSTRUCTION AND USE OF THE VARIOUS BETA-RAY DETECTORS. See Abstr. 9340

539.1.07

9231 EFFECT OF GASEOUS IMPURITIES ON BF_3 PROPORTIONAL COUNTERS. J.D.Aponte and S.A.Korff.
Rev. sci. Instrum., Vol. 31, No. 5, 532-6 (May, 1960).

The effect which SiF_4, SO_2, and SF_6 have on the plateau and the pulse size distribution of a proportional counter were investigated. SiF_4 was tested at three pressures, 30, 45, and 60 cm, of BF_3 and its effect was found to be independent of the counter pressure for the range of value considered. From the variation in the plateau, the attachment probability for SiF_4 was calculated to be $h = 1.485 \times 10^{-3}$ and its cross-section for attachment to be $\sigma_a = 5.12 \times 10^{-20}$ cm^2. The amount of these gases permitted, without the counter being affected beyond the limits of tolerance which are set up, were found to be 0.04% for SiF_4, 0.01% for SO_2, and 2.0×10^{-6}% for SF_6.

539.1.07

9232 ON THE ADEQUACY OF HALF-VALUE LAYER AS A CRITERION OF X-RAY QUALITY IN THE CALIBRATION OF DOSEMETERS. N.M.Procter and J.R.Greening.
Brit. J. Radiol., Vol. 33, 321-5 (May, 1960).

Five thimble ionization chambers were compared with a free-air chamber using X-rays produced at 20 to 55 kV with half-value layers (H.V.L.) between 0.05 and 0.20 mm Al. One chamber showed a difference of nearly 4 per cent in its correction factor for beams of the same H.V.L. produced at 20 and 55 kV. With this single exception H.V.L. appeared to be an adequate criterion of X-ray quality for the calibration of ionization chambers.

539.1.07

9233 SOME ASPECTS OF NUCLEAR PARTICLE DETECTION BY SCINTILLATION. H.Durand.
Onde elect., Vol. 38, 600-5 (Aug.-Sept., 1958). In French.

The paper describes the essential parts of a scintillation counter, the absorption process of nuclear radiations in matter, the scintillation mechanism in organic and inorganic phosphors and criteria for the choice of a good detector. I.C.Demetsopoullos

539.1.07 : 539.12

SCINTILLATOR TYPE DISPERSE DETECTORS OF FAST NEUTRONS. See Abstr. 7385

539.1.07 : 533.7 : 535.37

9234 SOME RESULTS ON GAS SCINTILLATORS AND THEIR CONDENSED STATES. L.Koch and R.Lesueur.
J. Phys. Radium, Vol. 19, No. 1, 103-5 (Jan., 1958). In French.

The essential characteristics of rare gases for use as scintillators are as follows: a very brief period of luminescence, generally less than 10^{-9} sec; a linear response as a function of the energy lost by the nuclear particle in the gas, even in the case of strongly ionizing particles. In the gaseous or condensed state, therefore, they are of great interest in nuclear physics.

539.1.07 : 532.7 : 535.37

SCINTILLATION IN HELIUM AT HIGH PRESSURES DUE TO ALPHA-PARTICLES. See Abstr. 8668

539.1.07

9235 PHOTOLUMINESCENT CHARACTERISTICS AND RELATIVE SCINTILLATION INTENSITIES OF PLASTIC SCINTILLATORS CONTAINING ANTHRACENE DERIVATIVES.
A.S.Cherkasov, G.A.Tishchenko and K.G.Voldaykina.
Optika i Spektrosk., Vol. 4, No. 3, 344-7 (1958). In Russian.
English summary: PB 141047 T -4, obtainable from Office of Technical Services, U.S.Dept. of Commerce, Washington, D.C., U.S.A.

Polystyrene solutions, each containing 2% by weight of one of 19 derivatives of anthracene, have been prepared, and their relative scintillation efficiencies, fluorescence spectra, photo-fluorescence quantum efficiencies and decay times have been measured. The most efficient solutions are those containing 9, 10-diphenyl-anthracene and 9,10-di-(n-anisyl)-anthracene, which are similar to equivalent terphenyl solutions. J.B.Birks

539.1.07

9236 ČERENKOV DETECTOR ACCURATELY MEASURING VELOCITY AND DIRECTION OVER A WIDE RANGE.
A.Roberts.
Rev. sci. Instrum., Vol. 31, No. 5, 579-80 (May, 1960).

A cascade image-intensifier is described using three intensifier tubes coupled by a lens system and of sufficient gain to register photographically the ring images of Cherenkov radiation; from these, precise measurements of particle velocity and direction are obtained. D.V.Mabbs

539.1.07

9237 TINY SEMICONDUCTOR IS FAST, LINEAR DETECTOR.
S.S.Friedland, J.W.Mayer and J.S.Wiggins.
Nucleonics, Vol. 18, No. 2, 54-9 (Feb., 1960).

Detectors made by shallow diffusion (< 1μ) of phosphorous into p-type high resistivity silicon have a linear response to protons up to 4.5 MeV and alphas up to 20 MeV. The energy resolution is 0.6% at 6 MeV (half-width at half-height). The response time is 3.5×10^{-9} sec. High bias voltage and high base resistivity are advantageous. R.D.Smith

539.1.07

9238 DETECTION OF ALPHA PARTICLES WITH COMMERCIALLY AVAILABLE TRANSISTORS. A.I.Yavin.
Rev. sci. Instrum., Vol. 31, No. 3, 351-2 (March, 1960).

The attractive features of these solid state particle detectors are that (i) they are small, (ii) they are one or two orders of magnitude more efficient than either gas ionization chambers or scintillation counters in converting particle energy into detected charge. These properties make them ideal for the detection of low energy recoils, especially inside gas targets. The pulses from commercially available transistors for Pb^{210} alpha-particles were measured and the results are given. The signal-to-noise ratio was 75 : 1. It is concluded that the pulse height is roughly proportional to energy. The pulse length was of the order of 40 μsec. The average energy loss for the formation of an electron-hole pair was found to be within 20% of 2.3 eV. C.F.Barnaby

539.1.07

9239 HIGH PRESSURE NEON FLASH TUBES.
H.Coxell and A.W.Wolfendale.
Proc. Phys. Soc., Vol. 75, Pt 3, 378-86 (March, 1960).

The properties of high-pressure neon flash-tubes (Conversi counters, cf Abstr. 8042 of 1955) suitable for the detection of cosmic rays are described. The tubes have high efficiency for flashing after traversal by ionizing particles, short sensitive time and low rate of spurious flashing. A search for an ageing effect was made by subjecting each of a batch of tubes to 10^9 flashes; no important deterioration in performance has been found. See also following abstract.

539.1.07

9240 ON THE EFFICIENCY OF THE NEON FLASH TUBE.
J.L.Lloyd.
Proc. Phys. Soc., Vol. 75, Pt 3, 387-94 (March, 1960).

Using simple assumptions, the expected efficiency of neon flash-tubes (Conversi counters) is calculated as a function of time delay and numerical results are given, subject to one adjustable parameter. Satisfactory agreement with experiment is obtained, and the diffusion coefficient for thermal electrons in neon at 1 atmosphere and 20°C is found to be 1800 ± 100 cm^2 sec^{-1}.

539.1.07

9241 THERMOLUMINESCENT DOSIMETRY HAS STORAGE STABILITY, LINEARITY.
J.H.Schulman, R.J.Ginther, R.D.Kirk and H.S.Goulart.
Nucleonics, Vol. 18, No. 3, 92, 95, 96, 98, 100, 102 (March, 1960).

Dosimeter disks were made of 1 in. diam. $\frac{1}{8}$ in. copper coated with a CaF_2:Mn phosphor fired in a clear sodium lead silicate glaze. After exposure the dose was measured by heating the disks to 340°C

in a special furnace and observing the luminescence with a photomultiplier. The sensitivity is limited to about 50 *mr* by the background luminescence acquired during storage. Doses of many hundred röntgens are measurable. R.D.Smith

539.1.07 : 61

9242 AUTOMATIC CONSTANT SIGNAL PLOTTER. A.Cole.
Rev. sci. Instrum., Vol. 31, No. 5, 539-43 (May, 1960).

The instrument described automatically maps two-dimensional contours of spatial intensity distributions (i.e., iso-dose, iso-potential, etc.). A fast response detector is driven by two reversible motors, one a scan drive, the other an error compensation drive. Sequential alteration of the roles of the two motors provides complete mapping of continuous or discontinuous contours. Provisions are made to assure 1% recording accuracy. A remote readout recorder allows isolation of the pick-up device. Maximum plotting speed is 36 in./min or about 5 min for a family of 10 contours in a 10 × 25 cm area.

539.1.07

9243 OPERATION OF HYDROGEN BUBBLE CHAMBERS IN HIGH-ENERGY PHOTON BEAMS.
D.C.Gates, R.W.Kenney, D.A.McPherson and W.P.Swanson.
Rev. sci. Instrum., Vol. 31, No. 5, 565-9 (May, 1960).

Operation of the Alvarez 4 in. hydrogen bubble chamber in a high energy photon beam is described, the techniques employed in several modes of operation are discussed, and the corresponding bubble chamber conditions are tabulated. Reduction of electron background was accomplished by beam hardening and by using a Mylar beam-entrance window on the chamber.

539.1.07

9244 EXTRA FINE-GRAINED NUCLEAR RESEARCH EMULSIONS.
N.A.Perfilov, N.R.Novikova and E.I.Prokof'eva.
J. nuclear Energy, Vol. 9, No. 1-4, 90-6 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 45 (1958).

The preparation of a very uniform fine-grained photographic emulsion is described. Good reproducibility of the emulsions is obtained by applying a potentiometer method of control during the emulsification process. The emulsion sensitivity can be varied so that charged particles from heavy fragments to relativistic particles can be recorded with a grain density of 60 grains per 100 μ of track.

539.1.07

9245 CHARACTERISTICS OF FUJI NUCLEAR EMULSION TYPE ET-7A. K.Imaeda.
Nuovo Cimento Suppl., Vol. 15, No. 3, 374-81 (1960).

The fundamental characteristics examined are the size of the developed grains, the sensitivity, the specific gravity of the emulsion under conditions of variable humidity and the stopping power. The density and the stopping power of 7A emulsion are very nearly the same as those of Ilford G5 emulsion under comparable conditions. For optimum resolution properties development for 15 to 30 minutes at 20 to 23°C is suggested. The diameter of the developed grains (0.60 ± 0.02 μm) is of the same order as those of G5 emulsion. S.J.St-Lorant

539.1.07

9246 EFFICIENCY IN AREA-SCANNING FOR EVENTS IN NUCLEAR EMULSIONS.
Y.K.Lim, J.E.Laby and V.D.Hopper.
Nuovo Cimento Suppl., Vol. 15, No. 3, 382-6 (1960).

The steps required to obtain an estimate of the efficiency of an area scan are outlined and the procedure is applied to two stacks, one composed of normal emulsion and the other of emulsion loaded with water. S.J.St-Lorant

539.1.07

9247 THE APPLICATION OF A CONICAL COLLIMATOR TO THE SCANNING OF SECTIONS. Yu.K.Khudenskii.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 639-40 (1959). In Russian.

A method is described for increasing the apparent aperture of a counter used for scanning weakly β- or γ-active surfaces. The point on the surface being scanned is at the common vertex of two truncated cones of slightly different angle. The aperture of the counter is a plane perpendicular to the common axis of the cones. Since only radiations passing straight down the gap between the cones are not absorbed, the effect is as if the common vertex were focused on the counter. For hard radiations cones may be of lead, about 50 mm long, 20-30 mm diameter at the thick end and 6-8 mm diameter at the thin end. For very soft radiations, cones of loaded plastic are satisfactory. A.F.Brown

539.1.07 : 539.12

INDIVIDUAL DETECTION OF ELECTRONS IN NUCLEAR EMULSIONS. See Abstr. 9334

539.1.07 : 621.317.74

9248 A DISTRIBUTED [PARAMETERS] PULSE-HEIGHT ANALYSER. A.Boucherie and J.Mey.
J. Phys. Radium, Vol. 19, No. 1, 98-9 (Jan., 1958). In French.

Presents a new type of fast multichannel pulse-height analyser using the principle of distributed circuits. A description of the circuits employed in the construction of a model with five channels is given. The resolving time of this device is 0.2 μs.

539.1.07 : 621.317.39

9249 FAST COINCIDENCE CIRCUIT WITH TIME ANALYSER. E.Rémy and K.Winter.
J. Phys. Radium, Vol. 18, Suppl. No. 7, 112A-115A (July, 1957). In French.

Precision in the measurement of neutron energies, by the time of traverse method, depends on the quality of coincidence circuits employed. Speed-up of measurements has been achieved recently by chronometric circuits which give rapid readings of different traverse times i.e. of the whole energy spectrum. A system is described with a resolution potential of 0.3 mμsec, a linear time scale in the range of 2 to 16 mμsec and independence from errors for signals above a given threshold. A.Reiss

539.1.07 : 621.317.39

9250 RECENT PROGRESS ON MULTICHANNEL TIME ANALYSERS. H.Guillon.
J. Phys. Radium, Vol. 19, No. 1, 100-2 (Jan., 1958). In French.

Various improvements in the accuracy and reliability of time analysers are reviewed. Difficulties encountered with the use of multichannel fast analysers are discussed.

539.1.07

9251 THE ADVANTAGES OF A MILEIKOWSKY SPECTROMETER WITH ASTIGMATIC FOCUSSING FOR MEASURING THE ENERGY DISTRIBUTION OF REACTIONS ON LIGHT NUCLEI. L.Bianchi and E.Cotton.
J. Phys. Radium, Vol 19, No. 1, 92-3 (Jan , 1958). In French.

For these reactions, the emitted particle energy depends appreciably on the angle of emission; using a double focusing spectometer which has a large entrance angle, this variation can be of the order of several %. With an astigmatic system ($n = 0.57$) and a variable tilting angle of exit slit (after suggestions of Mileikowsky, see Abstr. 6862-3 of 1953) it was possible to test for an improvement in the energy resolution.

539.1.07

9252 DOUBLE FOCUSING ZERO DISPERSION MAGNETIC SPECTROMETER.
R.A.Alvarez, K.L.Brown, W.K.H.Panofsky and C.T.Rockhold.
Rev. sci. Instrum., Vol. 31, No. 5, 556-64 (May, 1960).

The spectrometer consists of two magnets, each $n \simeq 0.25$, 110° deflection, 30 in. radius of curvature, bending the particles in the same sense. For the central momentum p_0, the useful solid angle Ω_0 is ~ 0.0055 sterad with a possibility of improvement to 0.01 sterad. The momentum acceptance Δp is in excess of ± 4% with a useful solid angle Ω of ~0.0015 sterad at the 4% points. For a point source and for the solid angles and momentum acceptances given, over 90% of the trajectories terminate within a circle of 2 in. diameter at the focal plane.

NUCLEAR FIELD THEORY

539.11

9253 ANALYTIC PROPERTIES OF CAUSAL COMMUTATORS. V.Ya.Fainberg.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1503-8 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1066-9 (Nov., 1959).

A simple derivation is given of the integral representation for

the causal commutator discovered by Jost and Lehmann (Abstr. 38 of 1958) and generalized by Dyson (Abstr. 5654 of 1958), which does not require the use of six dimensions. In the simpler cases (vertex part, two-particle matrix element) more detailed spectral formulas are found. On the basis of these formulae, it is shown that the two-particle scattering amplitude — for real values of the energy in the centre-of-mass system — is an analytic function of the square of the momentum transfer regular in the entire complex plane except for poles and cuts on the real axis.

539.11

9254 THE ANALYTIC PROPERTIES OF VERTEX PARTS IN QUANTUM FIELD THEORY. L.D.Landau.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 62-70 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 45-50 (Jan., 1960).

A general method is developed, on the basis of the diagram technique, for finding the singularities of quantities involved in quantum field theory.

539.11

9255 THE QUANTIZATION OF HALF-INTEGER SPIN FIELDS. D.V.Volkov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1560-6 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1107-11 (Nov., 1959).

A method of quantization is considered which is different from the usual one involving anticommutators and is consistent with the principle of relativistic causality, positive definiteness of the energy (for non-interacting fields), the Lagrangian formalism in Schwinger's formulation (Abstr. 8032 of 1954), and with invariance under T.C.P. transformations. The main difference between the proposed method and the usual one is that the maximal occupation number is two.

539.11

9256 S-MATRIX IN THE GENERALIZED QUANTIZATION METHOD. D.V.Volkov.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 518-23 (Feb., 1960). In Russian.

The formalism of the S-matrix for interacting electromagnetic field and half-spin particle field is considered. Particle field quantization is carried out according to a scheme suggested in the works of Green and the author (see preceding abstract). It is shown that the basic concepts of the conventional theory of S-matrices (N-produce, Wick's theorem, Feynman graphs) allow a simple generalization within the framework of the quantization scheme considered.

539.11

9257 APPLICATION OF THE DISPERSION-RELATIONS METHOD IN QUANTUM ELECTRODYNAMICS. V.Ya.Fainberg.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1361-71 (Nov., 1959). In Russian.

An approximate set of dispersion equations for the Green's function of the photon and vertex part was derived in quantum electrodynamics on the basis of the dispersion relations and unitarity conditions. The "nonsubtraction" procedure is employed in an asymptotic investigation of the solutions of the equations. Agreement with the renormalized perturbation theory when the fine structure constant tends to zero is taken as a boundary condition. It is shown that the vertex function asymptotically decreases with growth of the square of the photon 4-momentum $q^2 = (p_+ + p_-)^2$ for $p_+^2 = p_-^2 < m^2$ where p_-, p_+ are the electron and positron 4-momenta. This leads to finite renormalization of the charge in the approximation under consideration.

539.11

9258 THE METHOD OF DISPERSION RELATIONS AND PERTURBATION THEORY. N.N.Bogolyubov, A.A.Logunov and D.V.Shirkov.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 805-15 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 574-81 (March, 1960).

Both the idea and the results of the present investigation are related to Redmond's work (Abstr. 2054 of 1959) on the exclusion of nonphysical poles from the Green's function. In contrast to that work, one is concerned with the principle of summing the information obtained from perturbation theory in the integrand of the Källen–Lehmann spectral integral. On summing in this way the contributions from the "principal logarithmic diagrams" one obtains expressions for the photon propagation functions in quantum electrodynamics and for the meson propagation function in the symmetric theory which have all the essential properties of Redmond's result: the correct analytic behaviour in the complex plane of the momentum variable p^2 and a singularity with respect to the variable of the square of the charge e^2 at the point $e^2 = 0$. However, in contrast to Redmond's result, which yields correctly only the lowest order of perturbation theory, the expressions obtained here correspond to terms of arbitrarily high order in the perturbation theory expansions in the region of large p^2. By taking into account the lowest order logarithmic terms, it is shown that the region of applicability of the new formulae coincides with the region of applicability of the old formulae containing the logarithmic singularities, since it is restricted by the condition of smallness of the invariant charge. The technique of reducing the expressions so obtained to the renormalization-invariant form is illustrated by the example of the photon Green's function. Some remarks are made with respect to the possible situation in non-renormalizable theories.

539.11

9259 THEORIES WITH AN INDEFINITE METRIC. V.G.Vaks.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 467-9 (Aug., 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 37(10), No. 2, 332-4 (Feb., 1960).

The conditions of unitarity and macro-causality for the Lee model with an indefinite metric are investigated.

539.11

9260 THE ELECTROMAGNETIC INTERACTION IN THE HEISENBERG THEORY. Ya.I.Granovskii.

Zh. eksper. teor. Fiz., Vol. 37, No.2(8), 442-51 (Aug., 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 37(10), No. 2, 314-20 (Feb., 1960).

The interaction of nucleons at large distances is considered on the basis of a nonlinear Lagrangian of general form. By means of the Heisenberg commutation function, it is shown that there are forces with the Coulomb dependence on the distance and with a fine-structure constant equal to 1/138 (scalar theory). The causes of the absence of electromagnetic forces in the vector, tensor, and axial-vector theories are analused. Deviations from the Coulomb law and their effects on renormalization are discussed.

539.11

9261 ASYMMETRY OF WEAK INTERACTIONS. R.Nataf.

J. Phys. Radium, Vol. 19, No. 1, 18-27 (Jan., 1958). In French.

With examples from classical mechanics and electrodynamics, the definitions of invariance by space symmetry, of "intrinsic parity", and of orbital parity are recalled. In quantum mechanics, possible values of intrinsic parity are discussed for spin 0 particles, and for spin 1/2 particles, with non-vanishing, or with vanishing (neutrino) rest mass. The Weyl (two component) theory of the neutrino is given. The quantum field treatment of emission and absorption processes is reviewed, and the parity conservation theorem is given for P (spatial symmetry) invariant interactions. The experiments of Wu et al. (Abstr. 5593 of 1957) and of Garwin et al. (Abstr. 5642 of 1957) suggested by the Lee-Yang theory, are described. In conclusion, the failure of P and C (charge conjugation) invariance for weak interactions is shown to come from experimental evidence. The Lüders–Pauli theorem is mentioned, and the Landau hypothesis of PC invariance is given.

539.11

9262 AXIAL VECTOR CURRENT CONSERVATION IN WEAK INTERACTIONS. Y.Nambu.

Phys. Rev. Letters, Vol. 4, No. 7, 380-2 (April 1, 1960).

A suggested form for the axial vector nucleon current in beta decay, which becomes conserved in the limit of zero pion mass, is given. Using plausible assumptions about the behaviour of the form factors, one obtains the expression for the beta-decay of the pion, previously given by Goldberger and Treiman (Abstr. 6627 of 1958), which agrees well with experiment. The same method is then applied to the strangeness-non-conserving beta-decays, and the axial vector beta-decay coupling constant of the Λ is estimated to be about one tenth that of the nucleon. Some suggestions on the theoretical basis of the suggested form for the current are given. E.J.Squires

539.11

9263 NOTE ON SYMMETRY OF STRONG INTERACTIONS. L.Łukaszuk.
Nuclear Phys., Vol. 15, No. 3, 513-15 (March (1), 1960).

Discusses the physical consequences of a particular form of meson–baryon interaction, in the framework of Krolikowski's theory (Abstr. 1080 of 1959), where the relative strengths of coupling constants depend in effect on isobaric spin and strangeness.

R.J.N.Phillips

539.11

9264 THEORY OF MULTIPLE PRODUCTION OF PARTICLES AT HIGH ENERGY INTERACTION. E.L.Feinberg.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 208.

Brief note, substantially as follows: Fundamentals and conclusions of the hydrodynamical theory of multiple production are reviewed, mainly in connection with the problem of validity of space-time concepts at small intervals. The difference is emphasized between processes with complete ("head-on collisions") and incomplete ("peripherical collisions", i.e. collisions with exchange of a small number of mesons) transfer of energy between colliding particles. Interrelation of Landau and Heisenberg theories is considered. Special attention is paid to electromagnetic radiation, accompanying multiple production, and to β-interaction at high energies. For full text see "Uspekhi Fisicheskikh Nauc", Vol. 70, No. 2, p. 333-50, Feb., 1960 and for enlarged version see Proceedings of the High Energy Physics Conference, Kiev (1959).

539.11

9265 DETERMINATION OF THE POTENTIAL IN QUANTUM FIELD THEORY. M.A.Braun.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 816-22 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 582-6 (March, 1960).

The problem of the determination of the potential in quantum field theory is studied in relation to the limitations that are imposed on the transition amplitude by the conditions of orthonormality and completeness of the systems of states of the noninteracting and interacting particles. A nonlinear integral equation for the transition amplitude is used for the construction of the potential. It is shown that the potential so constructed correctly describes the scattering of particles in the range of energies in which production of new particles does not occur, and also the bound states. Problems associated with the non-uniqueness of the potential are discussed.

539.11

9266 COVARIANT SOLUTIONS OF THE BETHE–SALPETER EQUATION. H.S.Green and S.N.Biswas.
Progr. theor. Phys., Vol. 18, No. 2, 121-38 (Aug., 1957).

A fully covariant investigation is made of the Bethe–Salpeter equation for a pair of nucleons, with pseudo-scalar interaction (Abstr. 1469 of 1952). The "ladder" approximation is adopted, but pair creation and nucleonic recoil are accounted for exactly. Matrix solutions are obtained, with varying degrees of explicitness, for instantaneous and delayed interaction, vanishing and non-vanishing meson mass, and for vanishing and non-vanishing total energy. Important properties are disclosed which are either obscured or do not appear at all in non-relativistic approximation. First the Bethe–Salpeter equation is reduced to a pair of coupled differential equations in which the Dirac matrices appear only in the coupling. In the instantaneous interaction approximation, these can be reduced to a single covariant equation in a single variable, showing the radical influence of nucleon recoil on pair effects. When the instantaneous interaction approximation is discarded, new features appear. There is a discrete infinity of stable states corresponding to each one of the non-relativistic theories, requiring a new quantum number for their enumeration. Jastrow's hypothesis (Abstr. 3331 of 1951) of a repulsive "core" interaction is rigorously established, and the singularity is isolated. It is shown how to obtain solutions corresponding to states of higher angular momentum from those with $J = 0$, making use of the relativistic quantum enumeration. The conclusion is drawn that the relativistic quantum number is a property of the state of any pair of interaction particles, and its possible connection with the "strangeness" number is discussed.

539.11

9267 NONRELATIVISTIC SOLUTION OF THE BETHE–SALPETER EQUATION. A.I.Alekseev.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1435-7 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1020-1 (Nov., 1959).

This solution includes terms of the order of the relative velocity of the particles.

539.11

9268 PHYSICAL INTERPRETATION OF THE MATHEMATICAL EXPRESSION OF HUYGENS' PRINCIPLE IN THE ELECTRON THEORY OF DIRAC. Phan-Van-Loc.
Cahiers de Phys., Vol. 12, 328-40 (Sept., 1958).

The author discusses the diffraction of electron waves in terms of the electron current density, by which treatment the role of the density of the magnetic and electric moment becomes more explicit.

P.Roman

539.11

9269 SCATTERING OF DIRAC PARTICLES IN THE SECOND BORN APPROXIMATION.
V.M.Arutyunyan and R.M.Muradyan.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1542-5 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1094-6 (Nov., 1959).

The problem treated is that of the elastic scattering of Dirac particles by a fixed spherically symmetrical centre of force. The values of the scattering amplitudes are found in the second Born approximation.

539.11

9270 DIRAC-LIKE WAVE EQUATIONS FOR PARTICLES OF NONZERO REST MASS, AND THEIR QUANTIZATION.
J.S.Lomont and H.E.Moses.
Phys. Rev., Vol. 118, No. 1, 337-48 (April 1, 1960).

The basic algebraic structure of the Dirac equation for the electron is used as a model for wave equations for other particles of nonzero rest mass. Wave equations of the form $(\gamma^\mu \nabla_\mu + m)\psi = 0$, where the γ-matrices satisfy the usual Dirac anticommutation rules $[\gamma_\mu, \gamma_\nu]_+ = 2g_{\mu\nu}$ are then found for every positive integral and half-odd-integral spin. Wave equations of the above form describing multiple spin particles are also found. The improper transformations are given explicitly in their most general form, and quantization is performed. Finally, the vector meson field is treated as an example.

539.11 : 539.18

QUASI-CLASSICAL SOLUTIONS OF THE RADIAL DIRAC EQUATIONS. See Abstr. 7683

539.11

9271 ON THE PROBLEM OF THE ELEMENTARY CHARGE AND THE MESON MASSES. T.Neugebauer.
Acta phys. Hungar., Vol. 10, No. 3, 327-36 (1959). In German.

It is claimed that "on the model of a charged sphere containing exclusively electrons, it is shown by varying the value of the elementary charge, that the actually observed value of this constant is energetically the most favourable one". The same model is extended to describe heavier elementary particles, the electron gas in a metal, and also nuclei.

P.K.Kabir

539.11

9272 ALGEBRAIC THEORY OF MESONS AND BARYONS. J.M.Souriau.
C.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2807-9 (April 20, 1960). In French.

Proposes a seven-dimensional isospace in which mesons form a vector and baryons form a spinor. Suggests that strong interactions have the corresponding "symmetric" pseudoscalar form.

R.J.N.Phillips

539.11

9273 THE ANALOGUE OF POYNTING'S VECTOR FOR THE PSEUDOSCALAR MESON. V.Vrkljan.
Period math.-phys. astron. (Zagreb), Vol. 14, No. 4, 291-3 (1959). In German.

539.11

9274 A NEW CLASS OF REPRESENTATIONS OF THE FULL LORENTZ GROUP. G.A.Sokolik.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1098-1102 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 781-3 (Oct., 1959).

All representations of the full Lorentz group are found. It is shown that these representations reduce to direct products of spinors

belonging to three classes. An attempt is made to interpret isotopic spin in terms of the generalized parity operator without introducing new degrees of freedom. It is shown that the connection between spin and statistics may not hold for spinors which transform according to commuting representations.

539.11

9275 ALGEBRAIC DETERMINATION OF A SPINOR BY A PSEUDOVECTOR. O.Beaufays.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 9, 859-69 (1959). In French.

From a spinor in Minkowski space, a pseudovector is constructed. The extent to which the latter determines the former is studied.

R.J.N.Phillips

539.11

9276 RELATIVISTIC OPERATORS FOR MOMENTUM AND ANGULAR MOMENTUM. A.P.Gel'man.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 477-81 (Aug.,1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 339-41 (Feb., 1960).

Correct expressions for the relativistic operators for momentum and angular-momentum components in orthogonal curvilinear coordinates are derived by a systematic application of the theory of spinors.

539.11

9277 ON THE THEORY OF THE UNSTABLE PARTICLE. II. K.Naito.

Progr. theor. Phys., Vol. 18, No. 6, 614-20 (Dec., 1957).

A model which is more convenient than the Lee model for studying the theory of the unstable particle is proposed. In this model, the decayed particles are distinguished from the parental ones. The production and decay of an unstable particle is investigated by the stationary treatment. The conclusion is reached that it is possible to interpret the renormalization constant as the probability in the same way as for stable particles. For Pt I,see Abstr. 7286 (1960).

539.11

9278 POSSIBILITY OF SETTING UP A SYSTEM OF "ELEMENTARY" PARTICLES. I.V.Chuvilo.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1401-6 (Nov., 1959). In Russian.

A possibility of setting up a system of baryons and mesons based on the requirement of existence of a single "elementary" baryon and a single "elementary" meson and of a strong interaction between them is considered. The "elementary" particles chosen are the singlet baryon Ω^- with a strangeness of -3 and the isotopic doublet of K^+, K^0-mesons with a strangeness + 1. Some of the conclusions agree qualitatively with well-known experimental data on processes involving "strange particles". Some qualitative results relating to nucleon form-factors are also obtained.

539.11

9279 A METHOD FOR CALCULATION OF PHASE VOLUMES. L.G.Zastavenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1319-23 (Nov., 1959). In Russian.

A method for calculation of phase volumes (functions of the total energy and of the masses of particles) is developed for 2, 3, 4 and 5 particles. The error of the method increases with growth of the number of particles n, but does not exceed 5% for n = 5.

539.11

9280 ON THE NONLINEAR THEORY OF ELEMENTARY PARTICLES. D.F.Kurdgelaidze.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 462-74 (Feb , 1960). In Russian.

The energy and momentum of spinor fields with nonlinear pseudovector and scalar corrections are calculated on the basis of a number of new exact solutions of the wave type. The nucleon mass $k_0 l = \sqrt{2\pi^{3/2}} \cong 7.84$ is derived by semi-classical quantization. Dependence of the field energy on the degree of nonlinearity is established. From the nonlinear spinor equation a nonlinear undor equation is deduced which, under certain assumptions, can be reduced to a nonlinear meson equation of the Klein–Gordon type Homologic invariance of nonlinear meson and spinor field equations is considered.

539.11

9281 RELATIVISTIC SPHERICAL FUNCTIONS. II. A.Z.Dolginov and I.N.Toptygin.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1441-51 (Nov., 1959). In Russian.

Properties of infinitely-dimensional representations of the Lorentz group are considered, which are of interest in solution of problems of relativistic elementary particle theory. Infinitely dimensional representations are applied to an analysis of the amplitudes of the a + b → c + d reaction.

539.11

9282 LIFETIME MATRIX IN COLLISION THEORY. F.T.Smith.

Phys. Rev., Vol. 118, No. 1, 349-56 (April 1, 1960).

The duration of a collision is usually a rather ill-defined concept, depending on a more or less arbitrary choice of a collision distance. If the collision lifetime is defined as the limit, as $R \to \infty$, of the difference between the time the particles spend within a distance R of each other and the time they would have spent there in the absence of the interaction, a well-defined quantity emerges which is finite as long as the interaction vanishes rapidly enough at large R. In quantum mechanics, using steady-state wave functions, the average time of residence in a region is the integrated density divided by the total flux in (or out), and the lifetime is defined as the difference between these residence times with and without interaction. Transformation properties require construction of the lifetime matrix, Q. If the wave functions ψ_i are normalized to unit total flux in and out through a sphere at $R \to \infty$, the matrix elements are

$$Q_{ij} = \lim_{R\to\infty} \left[\int^{r<R} \psi_i \psi_j^* d\tau - R(v_i^{-1} \delta_{ij} + \Sigma_k S_{ik} v_k^{-1} S_{jk}^*) \right]_{Av}$$

where the average value is taken to eliminate oscillating terms at large R, S_{ik} is an element of the unitary scattering matrix, S, and v_i is the velocity in the i-th channel. Q is Hermitian; a diagonal element Q_{ii} is the average lifetime of a collision beginning in the i-th channel. As a function of the energy Q is related to S: $Q = i\hbar S dS^*/dE$; Q and S contain the same information, from complementary points of view. When Q is diagonalized, its proper values, q_{ii}, are the lifetimes of metastable states if they are large compared to $\hbar/E$; for a sharp resonance, the measured lifetime is the average of $q_{ii}(E)$ over a distribution in energy. The corresponding eigenfunctions, ϕ_i, are the proper functions to describe these metastable states. The causality principle appears directly from an inequality involving the integral expression for Q_{ii} or q_{ii}, and it is shown how some of its consequences for inelastic collisions can be deduced.

539.11

9283 CAUSALITY IN A THEORY WITH AN INDEFINITE METRIC. D.A.Slavnov and A.D.Sukhanov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1472-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1044-8 (Nov., 1959).

The possibility of constructing a unitary and macroscopically causal scattering matrix in a theory with an indefinite metric is examined. The construction is carried out in the framework of perturbation theory by means of the interaction Lagrangians of the complete (physical plus sum of nonphysical) fields. By a special choice of the spectrum of the nonphysical fields it is possible to satisfy the requirements of unitarity and macroscopic causality in the second and third orders. These requirements cannot, however, be fulfilled together in the fourth order; thus within the framework of the present assumptions it is not possible to construct a unitary and macroscopically causal scattering matrix in a theory with indefinite metric.

539.11

9284 A NEW APPROACH TO A BOUND STATE. T.Imamura.

Progr. theor. Phys., Vol. 18, No. 6, 559-66 (Dec., 1957).

The extended wave matrix which generates not only the eigenvectors for scattering states but also those for bound states from those of the free Hamiltonian is introduced. Using this operator, the problems in the non-perturbation approach are discussed in a general fashion for the case of the system involving bound states.

539.11

9285 CALCULATION OF THE COUPLING CONSTANT IN A NONLINEAR THEORY. Ya.I.Granovskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 192-6 (July 1959). In

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539.11

9263 NOTE ON SYMMETRY OF STRONG INTERACTIONS. L.Łukaszuk.
Nuclear Phys., Vol. 15, No. 3, 513-15 (March (1), 1960).

Discusses the physical consequences of a particular form of meson–baryon interaction, in the framework of Krolikowski's theory (Abstr. 1080 of 1959), where the relative strengths of coupling constants depend in effect on isobaric spin and strangeness.

R.J.N.Phillips

539.11

9264 THEORY OF MULTIPLE PRODUCTION OF PARTICLES AT HIGH ENERGY INTERACTION. E.L.Feinberg.
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539.11

9265 DETERMINATION OF THE POTENTIAL IN QUANTUM FIELD THEORY. M.A.Braun.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 816-22 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 582-6 (March, 1960).

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9266 COVARIANT SOLUTIONS OF THE BETHE–SALPETER EQUATION. H.S.Green and S.N.Biswas.
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A fully covariant investigation is made of the Bethe–Salpeter equation for a pair of nucleons, with pseudo-scalar interaction (Abstr. 1469 of 1952). The "ladder" approximation is adopted, but pair creation and nucleonic recoil are accounted for exactly. Matrix solutions are obtained, with varying degrees of explicitness, for instantaneous and delayed interaction, vanishing and non-vanishing meson mass, and for vanishing and non-vanishing total energy. Important properties are disclosed which are either obscured or do not appear at all in non-relativistic approximation. First the Bethe–Salpeter equation is reduced to a pair of coupled differential equations in which the Dirac matrices appear only in the coupling. In the instantaneous interaction approximation, these can be reduced to a single covariant equation in a single variable, showing the radical influence of nucleon recoil on pair effects. When the instantaneous interaction approximation is discarded, new features appear. There is a discrete infinity of stable states corresponding to each one of the non-relativistic theories, requiring a new quantum number for their enumeration. Jastrow's hypothesis (Abstr. 3331 of 1951) of a repulsive "core" interaction is rigorously established, and the singularity is isolated. It is shown how to obtain solutions corresponding to states of higher angular momentum from those with $J = 0$, making use of the relativistic quantum enumeration. The conclusion is drawn that the relativistic quantum number is a property of the state of any pair of interaction particles, and its possible connection with the "strangeness" number is discussed.

539.11

9267 NONRELATIVISTIC SOLUTION OF THE BETHE–SALPETER EQUATION. A.I.Alekseev.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1435-7 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1020-1 (Nov., 1959).

This solution includes terms of the order of the relative velocity of the particles.

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9268 PHYSICAL INTERPRETATION OF THE MATHEMATICAL EXPRESSION OF HUYGENS' PRINCIPLE IN THE ELECTRON THEORY OF DIRAC. Phan-Van-Loc.
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9269 SCATTERING OF DIRAC PARTICLES IN THE SECOND BORN APPROXIMATION.
V.M.Arutyunyan and R.M.Muradyan.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1542-5 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1094-6 (Nov., 1959).

The problem treated is that of the elastic scattering of Dirac particles by a fixed spherically symmetrical centre of force. The values of the scattering amplitudes are found in the second Born approximation.

539.11

9270 DIRAC-LIKE WAVE EQUATIONS FOR PARTICLES OF NONZERO REST MASS, AND THEIR QUANTIZATION.
J.S.Lomont and H.E.Moses.
Phys. Rev., Vol. 118, No. 1, 337-48 (April 1, 1960).

The basic algebraic structure of the Dirac equation for the electron is used as a model for wave equations for other particles of nonzero rest mass. Wave equations of the form $(\gamma^\mu \nabla_\mu + m)\psi = 0$, where the γ-matrices satisfy the usual Dirac anticommutation rules $[\gamma_\mu, \gamma_\nu]_+ = 2g_{\mu\nu}$ are then found for every positive integral and half-odd-integral spin. Wave equations of the above form describing multiple spin particles are also found. The improper transformations are given explicitly in their most general form, and quantization is performed. Finally, the vector meson field is treated as an example.

539.11 : 539.18

QUASI-CLASSICAL SOLUTIONS OF THE RADIAL DIRAC EQUATIONS. See Abstr. 7683

539.11

9271 ON THE PROBLEM OF THE ELEMENTARY CHARGE AND THE MESON MASSES. T.Neugebauer.
Acta phys. Hungar., Vol. 10, No. 3, 327-36 (1959). In German.

It is claimed that "on the model of a charged sphere containing exclusively electrons, it is shown by varying the value of the elementary charge, that the actually observed value of this constant is energetically the most favourable one". The same model is extended to describe heavier elementary particles, the electron gas in a metal, and also nuclei.

P.K.Kabir

539.11

9272 ALGEBRAIC THEORY OF MESONS AND BARYONS. J.M.Souriau.
C.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2807-9 (April 20, 1960). In French.

Proposes a seven-dimensional isospace in which mesons form a vector and baryons form a spinor. Suggests that strong interactions have the corresponding "symmetric" pseudoscalar form.

R.J.N.Phillips

539.11

9273 THE ANALOGUE OF POYNTING'S VECTOR FOR THE PSEUDOSCALAR MESON. V.Vrkljan.
Period math.-phys. astron. (Zagreb), Vol. 14, No. 4, 291-3 (1959). In German.

539.11

9274 A NEW CLASS OF REPRESENTATIONS OF THE FULL LORENTZ GROUP. G.A.Sokolik.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1098-1102 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 781-3 (Oct., 1959).

All representations of the full Lorentz group are found. It is shown that these representations reduce to direct products of spinors

belonging to three classes. An attempt is made to interpret isotopic spin in terms of the generalized parity operator without introducing new degrees of freedom. It is shown that the connection between spin and statistics may not hold for spinors which transform according to commuting representations.

539.11

9275 ALGEBRAIC DETERMINATION OF A SPINOR BY A PSEUDOVECTOR. O.Beaufays.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 9, 859-69 (1959). In French.

From a spinor in Minkowski space, a pseudovector is constructed. The extent to which the latter determines the former is studied.

R.J.N.Phillips

539.11

9276 RELATIVISTIC OPERATORS FOR MOMENTUM AND ANGULAR MOMENTUM. A.P.Gel'man.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 477-81 (Aug.,1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 339-41 (Feb., 1960).

Correct expressions for the relativistic operators for momentum and angular-momentum components in orthogonal curvilinear coordinates are derived by a systematic application of the theory of spinors.

539.11

9277 ON THE THEORY OF THE UNSTABLE PARTICLE. II. K.Naito.

Progr. theor. Phys., Vol. 18, No. 6, 614-20 (Dec., 1957).

A model which is more convenient than the Lee model for studying the theory of the unstable particle is proposed. In this model, the decayed particles are distinguished from the parental ones. The production and decay of an unstable particle is investigated by the stationary treatment. The conclusion is reached that it is possible to interpret the renormalization constant as the probability in the same way as for stable particles. For Pt I, see Abstr. 7286 (1960).

539.11

9278 POSSIBILITY OF SETTING UP A SYSTEM OF "ELEMENTARY" PARTICLES. I.V.Chuvilo.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1401-6 (Nov., 1959). In Russian.

A possibility of setting up a system of baryons and mesons based on the requirement of existence of a single "elementary" baryon and a single "elementary" meson and of a strong interaction between them is considered. The "elementary" particles chosen are the singlet baryon Ω^- with a strangeness of -3 and the isotopic doublet of K^+, K^0-mesons with a strangeness + 1. Some of the conclusions agree qualitatively with well-known experimental data on processes involving "strange particles". Some qualitative results relating to nucleon form-factors are also obtained.

539.11

9279 A METHOD FOR CALCULATION OF PHASE VOLUMES. L.G.Zastavenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1319-23 (Nov., 1959). In Russian.

A method for calculation of phase volumes (functions of the total energy and of the masses of particles) is developed for 2, 3, 4 and 5 particles. The error of the method increases with growth of the number of particles n, but does not exceed 5% for n = 5.

539.11

9280 ON THE NONLINEAR THEORY OF ELEMENTARY PARTICLES. D.F.Kurdgelaidze.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 462-74 (Feb , 1960). In Russian.

The energy and momentum of spinor fields with nonlinear pseudovector and scalar corrections are calculated on the basis of a number of new exact solutions of the wave type. The nucleon mass $k_0 l = \sqrt{2\pi^{3/3}} \cong 7.84$ is derived by semi-classical quantization. Dependence of the field energy on the degree of nonlinearity is established. From the nonlinear spinor equation a nonlinear undor equation is deduced which, under certain assumptions, can be reduced to a nonlinear meson equation of the Klein–Gordon type Homologic invariance of nonlinear meson and spinor field equations is considered.

539.11

9281 RELATIVISTIC SPHERICAL FUNCTIONS. II. A.Z.Dolginov and I.N.Toptygin.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1441-51 (Nov., 1959). In Russian.

Properties of infinitely-dimensional representations of the Lorentz group are considered, which are of interest in solution of problems of relativistic elementary particle theory. Infinitely dimensional representations are applied to an analysis of the amplitudes of the a + b → c + d reaction.

539.11

9282 LIFETIME MATRIX IN COLLISION THEORY. F.T.Smith.

Phys. Rev., Vol. 118, No. 1, 349-56 (April 1, 1960).

The duration of a collision is usually a rather ill-defined concept, depending on a more or less arbitrary choice of a collision distance. If the collision lifetime is defined as the limit, as $R \to \infty$, of the difference between the time the particles spend within a distance R of each other and the time they would have spent there in the absence of the interaction, a well-defined quantity emerges which is finite as long as the interaction vanishes rapidly enough at large R. In quantum mechanics, using steady-state wave functions, the average time of residence in a region is the integrated density divided by the total flux in (or out), and the lifetime is defined as the difference between these residence times with and without interaction. Transformation properties require construction of the lifetime matrix, Q. If the wave functions ψ_i are normalized to unit total flux in and out through a sphere at $R \to \infty$, the matrix elements are

$$Q_{ij} = \lim_{R\to\infty}\left[\int^{r<R} \psi_i\psi_j^* d\tau - R(v_i^{-1}\delta_{ij} + \Sigma_k S_{ik}v_k^{-1}S_{jk}^*)\right]_{Av}$$

where the average value is taken to eliminate oscillating terms at large R, S_{ik} is an element of the unitary scattering matrix, S, and v_i is the velocity in the i-th channel. Q is Hermitian; a diagonal element Q_{ii} is the average lifetime of a collision beginning in the i-th channel. As a function of the energy Q is related to S: $Q = i\hbar S\, dS^+/dE$; Q and S contain the same information, from complementary points of view. When Q is diagonalized, its proper values, q_{ii}, are the lifetimes of metastable states if they are large compared to $\hbar/E$; for a sharp resonance, the measured lifetime is the average of $q_{ii}(E)$ over a distribution in energy. The corresponding eigenfunctions, ϕ_i, are the proper functions to describe these metastable states. The causality principle appears directly from an inequality involving the integral expression for Q_{ii} or q_{ii}, and it is shown how some of its consequences for inelastic collisions can be deduced.

539.11

9283 CAUSALITY IN A THEORY WITH AN INDEFINITE METRIC. D.A.Slavnov and A.D.Sukhanov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1472-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1044-8 (Nov., 1959).

The possibility of constructing a unitary and macroscopically causal scattering matrix in a theory with an indefinite metric is examined. The construction is carried out in the framework of perturbation theory by means of the interaction Lagrangians of the complete (physical plus sum of nonphysical) fields. By a special choice of the spectrum of the nonphysical fields it is possible to satisfy the requirements of unitarity and macroscopic causality in the second and third orders. These requirements cannot, however, be fulfilled together in the fourth order; thus within the framework of the present assumptions it is not possible to construct a unitary and macroscopically causal scattering matrix in a theory with indefinite metric.

539.11

9284 A NEW APPROACH TO A BOUND STATE. T.Imamura.

Progr. theor. Phys., Vol. 18, No. 6, 559-66 (Dec., 1957).

The extended wave matrix which generates not only the eigenvectors for scattering states but also those for bound states from those of the free Hamiltonian is introduced. Using this operator, the problems in the non-perturbation approach are discussed in a general fashion for the case of the system involving bound states.

539.11

9285 CALCULATION OF THE COUPLING CONSTANT IN A NONLINEAR THEORY. Ya.I.Granovskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 192-6 (July 1959). In

Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 135-7 (Jan., 1960).

The coupling constant is expressed in terms of the proton mass in the second approximation of the Tamm–Dancoff method. The formulae obtained can be used in the case in which the Lagrangian is an arbitrary linear combination of the five basic invariants.

539.11

9286 BINDING ENERGY OF A NEUTRON GAS. K.A.Brueckner, J.L.Gammel and J.T.Kubis.
Phys. Rev., Vol. 118, No. 4, 1095-7 (May 15, 1960).

The energy of a neutron gas is determined as a function of density using the methods of Breckner and Gammel (Abstr. 2515 of 1958). The system is unbound at all densities. The change in energy from a superconducting type of level inversion is estimated and shown to be negligible.

539.11 : 530.12

9287 QUANTIZED MESON FIELD IN A CLASSICAL GRAVITATIONAL FIELD. T.Imamura.
Phys. Rev., Vol. 118, No. 5, 1430-4 (June 1, 1960).

The behaviour of a quantized meson field in a classical gravitational field is examined. Physical quantities such as the expectation value for the number of created mesons are represented in terms of a formal Green's function. They are computed explicitly for the case of a special space-independent gravitational field. The inadequacy of standard iteration procedures is also discussed.

539.11 : 539.18

9288 UPPER BOUNDS ON SCATTERING LENGTHS WHEN COMPOSITE BOUND STATES EXIST.
L.Rosenberg, L.Spruch and T.F.O'Malley.
Phys. Rev., Vol. 118, No. 1, 184-92 (April 1, 1960).

For previous work, see Abstr. 2496, 5863 of 1960. In the case of the zero-energy scattering of one compound system by another, where one real scattering length completely characterizes the problem (e.g., the reaction $A + B \rightarrow C + D$, in addition to $A + B \rightarrow A + B$, cannot take place) it has previously been shown that the Kohn–Hulthen variational principle provides and upper bound on the scattering length if no composite bound states exist. The extension of this result to the case where one or more composite bound states do exist is presented here. The inclusion of tensor forces, exchange forces, and Coulomb forces is allowed. Several methods are given for obtaining a rigorous upper bound on the scattering length, which involve the addition of certain positive terms to the Kohn–Hulthen variational expression. The approximate information about the composite bound states which is required to construct these additional terms can be found by standard methods. As a consequence of one of the results obtained, it is shown that under certain circumstances some ordinary variational calculations give a bound. Thus, an analysis of a previous calculation in the light of the present results leads, without further calculations, to a rigorous upper bound on the singlet electron–hydrogen scattering length.

539.11

9289 HIGH-ENERGY BEHAVIOR IN QUANTUM FIELD THEORY. S.Weinberg.
Phys. Rev., Vol. 118, No. 3, 838-49 (May 1, 1960).

An attack is made on the problem of determining the asymptotic behaviour at high energies and momenta of the Green's functions of quantum field theory, using new mathematical methods from the theory of real variables. A class A_n of functions of n real variables is defined, whose asymptotic behaviour may be specified in a certain manner by means of certain "asymptotic coefficients". The Feynman integrands of perturbation theory (with energies taken imaginary) belong to such classes. It is then proved that if certain conditions on the asymptotic coefficients are satisfied then an integral over k of the variables converges, and belongs to the class A_{n-k} with new asymptotic coefficients simply related to the old ones. When applied to perturbation theory this theorem validates the renormalization procedure of Dyson and Salam, proving that the renormalized integrals actually do always converge, and provides a simple rule for calculating the asymptotic behaviour of any Green's function to any order of perturbation theory.

539.11

9290 APPLICABILITY CONDITIONS OF THE HYDRODYNAMICAL MODEL OF MULTIPLE PRODUCTION OF PARTICLES FROM THE POINT OF VIEW OF QUANTUM FIELD THEORY. C.Iso, K.Mori and M.Namiki.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 226-30.

By making use of methods based on quantum statistical mechanics of irreversible processes, it is attempted to investigate whether the hydrodynamical description is applicable to the meson cloud as considered in Landau's theory of the multiple production of particles.

539.11

9291 MULTIPLE PRODUCTION OF PARTICLES AND HYDRODYNAMICAL ASPECT OF QUANTUM THEORY OF FIELDS. M.Namiki and C.Iso.
Progr. theor. Phys., Vol. 18, No. 6, 591-613 (Dec., 1957).

The theory of irreversible processes based on quantum statistical mechanics is formulated within the framework of quantum field theory, to investigate whether the hydrodynamical description is applicable to the meson cloud as considered in Landau's theory of multiple production of particles. The hydrodynamical quantities are defined from the field-theoretical operators by quantum statistical averaging procedures. From the relation between the equation of state of meson–nucleon fluid and the feature of the interactions, it is concluded that at extremely high energy the equation of state assumed by Landau only holds for the first kind of interactions (having dimensionless coupling constants), and not for systems with the second kind of interactions (having coupling constants with dimension). In particular, the violation of Landau's equation would be serious in the case of interactions with derivatives. Formulae are given for calculating the phenomenological coefficients which are considered as representing the properties of the fluid. The formulae include calculations of the relaxation time, the time for a system to reach the local equilibrium. Methods are given for estimating deviations from the macroscopic values of physical quantities predicted by the hydrodynamics of fluctuations. [A preliminary note has been published. See Abstr. 49 of 1958].

539.11

9292 THEORY OF MULTIPLE SCATTERING. E.Breitenberger.
Proc. Roy. Soc. A, Vol. 250, 514-23 (April 7, 1959).

The rigorous theory of multiple scattering is developed for monoergic particles incident normally on a plane parallel, homogeneous, amorphous foil. All formulae are given in terms of the single-scattering function, the collision frequency per unit path, and the foil thickness. The underlying random flight problem is formally solved by a set of interlocking recurrence relations. The multiple scattering function is found to depend upon solution of a complicated integral equation, which is discussed in particular for the case of forward scattering. A first forward approximation leads to the general formula of Goudsmith and Saunderson (1940) which, like the equivalent theory of Molière, is therefore valid up to about 10^0 only. In a second approximation, valid up to about 35^0, the basic integral equation must be iterated; the first iterate of the multiple scattering function is obtained explicitly in terms of the simpler first approximation.

539.11

9293 COMPLEX EIGENVALUES IN SCATTERING THEORY. R.E.Peierls.
Proc. Roy. Soc. A, Vol. 253, 16-36 (Nov. 17, 1959).

The non-relativistic problem of scattering of a particle by a target possessing discrete excited states can be expressed in terms of "physical" resonance states, i.e. solutions of the wave equation for complex energy in which, in the asymptotic form of the wave-function in each channel, one of the two possible exponential terms (which for real energy represent the incoming and outgoing wave) vanishes. This representation is possible provided that interaction between the particles and the target vanishes exactly beyond a certain distance. If the interaction decreases exponentially a similar representation may in some cases still be obtained by analytic continuation; it contains also "redundant" eigenstates in which the coefficient of one of the asymptotic waves tends to infinity. Possible generalizations of the method are discussed.

539.11

9294 CRITICISM ON THE ASSUMPTIONS IN THE FORMAL SCATTERING THEORY. T.Imamura.
Progr. theor. Phys., Vol. 18, No. 1, 51-65 (July, 1957).

The conditions which give a well-defined meaning to the mathematical expressions appearing in formal scattering theory are derived. These conditions remove some restrictions that are usually imposed on the spectra of H and H_0. Using these conditions the

equivalence between two kinds of S-matrices given by Heisenberg and Dyson, respectively, the adiabatic theorem in the quantum field theory, and other problems can be systematically discussed. The rearrangement collisions can also be investigated from this viewpoint.

539.11

9295 SCATTERING OF HIGH-ENERGY NUCLEONS BY A NONLOCAL POTENTIAL.

R.H.Lemmer, Y.C.Tang and W.E.Frahn.

Phys. Rev., Vol. 118, No. 1, 269-70 (April 1, 1960).

The scattering of high-energy nucleons by a simple nonlocal potential is examined in the Born approximation. It is shown that an energy dependent local potential is not fully equivalent to a nonlocal potential. The latter potential introduces an additional angular dependence in the differential cross-section which seems to be particularly significant in the backward directions.

539.11

9296 A POSSIBILITY OF DETERMINING THE SCATTERING AMPLITUDES OF UNSTABLE PARTICLES AT ZERO ENERGY. V.N.Gribov.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 553-69 (Feb., 1960). In Russian.

A possibility of determining the scattering amplitudes of unstable particles by analysing the energy and angular distributions of reactions in which they are produced is discussed. Reactions involving formation of two particles ($\pi + N \to \Lambda + K, \Sigma + K$) and three particles ($N + N \to N + \Lambda + K$) of which two interact resonantly at low energies are considered.

539.11

9297 ANGULAR AND POLARIZATION ANALYSES OF REACTIONS OF THE TYPE $a + b \to a' + b' + c'$.

V.I.Ritus.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 217-23 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 153-7 (Jan., 1960).

A study is made of the invariant angular operators in terms of which the scattering matrix for reactions of the type $a + b \to a' + b' + c'$ can be expanded, and which are convenient for angular and polarization analyses of such reactions. The angular operators are obtained in explicit form for reactions in which the spin of the system does not exceed unity, and also for analogous reactions involving γ-ray quanta.

539.11 : 530.16

9298 QUANTUM MECHANICAL TRANSPORT THEORY. I. INCOHERENT PROCESSES. K.M.Watson.

Phys. Rev., Vol. 118, No. 4, 886-98 (May 15, 1960).

The transport of particles through a scattering medium is studied. A generalization of a technique due to Placzek (Abstr. 5341 of 1952) and Wick (Abstr. 7778 of 1954) is used to handle sums over states of excitation of the medium. The collision processes which occur are classified as "inelastic", "elastic", and "quasi-elastic" and correspond to different orderings of the Placzek–Wick series. The inelastic scatterings are described by an essentially classical transport equation and the elastic scatterings by assigning a refractive index to the medium. The "quasi-elastic" scattering involves the excitation of low-lying states of the scattering system. The coherent interference of waves scattered from nearby scatterers is important in this case and depends upon the structure of the medium. In this paper the general theory is developed in terms of a systematic sequence of approximations, of which the first gives just the classical form of transport theory. The correction terms then appear as quantum-mechanical corrections to the classical transport problem.

539.11 : 539.12

9299 DISPERSION RELATIONS AND CHEW–LOW TYPE EQUATIONS FOR INELASTIC MESON PROCESSES IN THE FIXED SOURCE CASE. V.Tseliner.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1103-9 (April, 1960). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 38 (9), No. 4, 784-8 (Oct., 1959).

The static dispersion relations and Chew–Low equations are established for the process $\pi + N \to n\pi + N$. It turns out that for this process one can obtain physically different dispersion relations and Chew–Low equations, depending on how the variables are chosen.

539.11

9300 NEW DISPERSION RELATIONS IN QUANTUM FIELD THEORY. L.A.Khalfin.

Zh. eksper. teor, Fiz., Vol. 36, No. 4, 1088-92 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36 (9), No. 4, 774-6 (Oct., 1959).

Some new dispersion relations are obtained between the modulus and the phase shift of the forward scattering amplitude. In contrast to the usual dispersion relations (between the real and imaginary parts of the forward scattering amplitude), the present relations do not depend on the detailed behaviour (degree of increase or decrease) of the forward scattering amplitude at infinite energy. The possible existence of zeros in the forward scattering amplitude in its region of analyticity is investigated.

539.11 : 539.18

THE CORRELATION ENERGIES OF THE HELIUM SEQUENCE. See Abstr. 9739

539.11

9301 WAVE-EQUATIONS WITH ZERO AND NON-ZERO REST MASSES. V.I.Ogievetskii and I.V.Polubarinov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 470-6 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 335-8 (Feb., 1960).

It is shown that wave-equations with non-zero rest mass are invariant with respect to a 15-parameter group of transformations which is a representation of the conformal group.

539.11

9302 REMARKS ON MAYER'S REDUCED DENSITY MATRIX METHOD. Y.Mizuno and T.Izuyama.

Progr. theor. Phys., Vol. 18, No. 1, 33-8 (July, 1957).

See also Abstr. 5080 (1954). Mayer has proposed a variation method of finding the two-body reduced density matrix ρ_2 for the ground state of a many fermion system (Abstr. 1498 of 1956). It is shown explicitly that the variation method is imperfect and sometimes leads to quite unsatisfactory results. Further, the trial form of ρ_2 for electron gas is translated into that for the π electron system of the benzene molecule and it is shown that such a trial form is unsatisfactory in several respects.

539.11

9303 DESCRIPTION OF PAULI MATTER AS A CONTINUOUS ASSEMBLY OF SMALL ROTATING BODIES.

T.Takabayasi and J.P.Vigier.

Progr. theor. Phys., Vol. 18, No. 6, 573-90 (Dec., 1957).

Kramers' method of representing a two-component spinor is revised and developed to formulate the quantum mechanical theory of a non-relativistic spinning particle. The method is unified with the hydrodynamical representation of the Pauli electron theory established previously (Abstr. 6765 of 1955; 6355 of 1956), giving the picture of the Pauli field as an assembly of very small rotating bodies (distinct from usual rigid bodies) continuously distributed in space. The formalistic and physical features of these new representations are considered. The characteristics of the former hydrodynamical formulation are discussed. It is pointed out that Planck's constant enters this scheme only as a constant signifying the magnitude of the spin.

539.11

9304 TREATMENT OF QUANTUM-MECHANICAL MANY-BODY PROBLEMS USING TWO-BODY WAVE-FUNCTIONS. E.Kroner.

Z. Naturforsch., Vol. 15a, No. 3, 260-5 (March, 1960). In German.

The density matrix for a system of N fermions, interacting through two-body forces, is expanded in terms of the solutions of a related two-body Schrödinger equation following Bopp (Abstr. 2115 of 1960). This expansion often converges better than expansions based on single particle wavefunctions, but there are difficulties in applying the method due to the necessity for the state to be anti-symmetrical. It is shown how these difficulties can be overcome, and a satisfactory approximation scheme obtained. The parameters expressing the antisymmetrical states in terms of the non-symmetrized functions are given by a recursion formula.

E.J.Squires

539.11 : 539.12

9305 STATISTICAL WEIGHTS OF MANY-PARTICLE SYSTEMS IN SPIN OR ISOSPIN SPACE. F.Cerulus.
Nuovo Cimento Suppl., Vol. 15, No. 3, 402-25 (1960).

There are tabulated the statistical weights of various final states, which are likely to arise in meson production. The final states considered contain at the most two spin $\frac{1}{2}$ and $\frac{3}{2}$ particles, and up to eight spin 1 particles. A.M.Green

ELEMENTARY PARTICLES

539.12

9306 THE INTRODUCTION OF AN "ELEMENTARY LENGTH" IN THE RELATIVISTIC THEORY OF ELEMENTARY PARTICLES. Yu.A.Gol'fand.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 504-9 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 356-60 (Feb., 1960).

A momentum space of constant curvature is introduced into the theory in place of the pseudo-Euclidean momentum space. The Feynman diagram technique is suitably generalized. Finite results are obtained in the lowest order perturbation theory approximation for the fermion and boson self-energy.

539.12 : 539.17

9307 THE KINEMATICS OF ELEMENTARY INTERACTIONS. N.G.Birger and Yu.A.Smorodin.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1159-67 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 823-9 (Oct., 1959).

Kinematic methods for the analysis of nuclear reactions of fast particles are considered. Application of such a method of analysis of the interactions observed in cloud chambers and photographic emulsions permits one to obtain angular and energy characteristics of the interaction in the centre-of-mass system of the colliding particles.

539.12

9308 ON THE MASS OF THE LEPTONS. Yu.A.Gol'fand.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11) 1493-4 (Nov., 1959). In Russian.

An attempt is made to explain the mass-difference between electron and muon by assuming that the low value of the electron mass has its origin in an anomalous μ–e interaction. P.Roman

539.12

9309 DETERMINATION OF CHARGED PARTICLE MASS FROM SCATTERING AND RESIDUAL RANGE IN MULTIPLATE CLOUD CHAMBERS. F.R.Arutyunyan.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 985-91 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 697-701 (Oct., 1959).

The method is experimentally checked by using it to determine the masses of protons, μ- and π-mesons identified independently (from momentum–range data). The proton, μ- and π-meson masses derived from the corresponding multiple Coulomb scattering curves are in good agreement with the correct values.

539.12

9310 COMPARISON OF THE CHARGES OF THE ELECTRON, PROTON AND NEUTRON.
A.M.Hillas and T.E.Cranshaw.
Nature (London), Vol. 186, 459-60 (May 7, 1960).

Some remarks on certain aspects of the experiment criticized by Bondi and Lyttleton (Abstracts 5521-2 of 1960).

S.J.St-Lorant

539.12

9311 THEORETICAL SURVEY OF β-DECAY AND μ-DECAY. D.L.Pursey.
Proc. Roy. Soc. A, Vol. 246, 444-53 (Aug. 26, 1958).

This paper, together with the six succeeding ones, is a report of a discussion meeting on the subject of parity non-conservation, held in December 1957. Each contribution is in the nature of a survey of some branch of particle physics (indicated by the title) affected by the discovery of parity non-conservation, and of a progress report as of the end of 1957. R.F.Peierls

539.12

9312 SURVEY OF THE EXPERIMENTAL SITUATION IN β-DECAY. M.A.Grace.
Proc. Roy. Soc. A, Vol. 246, 454-61 (Aug. 26, 1958).

539.12

9313 PION AND MUON DECAY. J.M.Cassels.
Proc. Roy. Soc. A, Vol. 246, 463-5 (Aug. 26, 1958).

539.12

9314 MEASUREMENT OF ELECTRON POLARIZATION. P.E.Cavanagh.
Proc. Roy. Soc. A, Vol. 246, 466-70 (Aug. 26, 1958).

539.12

9315 THE MEASUREMENT OF ELECTRON–NEUTRINO ANGULAR CORRELATIONS. B.W.Ridley.
Proc. Roy. Soc. A, Vol. 246, 471-4 (Aug. 26, 1958).

539.12

9316 PARITY CONSERVATION IN STRONG INTERACTIONS. D.H.Wilkinson.
Proc. Roy. Soc. A, Vol. 246, 481-2 (Aug. 26, 1958).

539.12

9317 PARITY VIOLATION IN STRANGE-PARTICLE DECAYS. A.Salam.
Proc. Roy. Soc. A, Vol. 246, 482-6 (Aug. 26, 1958).

539.12

9318 INTERNAL SYMMETRIES OF ELEMENTARY PARTICLES, AND OF THEIR INTERACTIONS. T.Takabayasi.
Cahiers de Phys., Vol. 13, 27-33 (Jan., 1959). In French.

A survey and discussion of various types of symmetry. R.J.N.Phillips

539.12

9319 INTRODUCTION OF "DAMPING" FUNCTIONS INTO [THE THEORY OF] SCATTERING CORRELATIONS. V.A.Fok and F.M.Kuni.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1195-8 (Aug. 21, 1959). In Russian.

The presence of "non-physical" energy regions forbids direct identification of scattering correlations with experimental data. In order to determine the possibility of analytic continuation of the scattering amplitude into the upper half of energy plane, from its known values in "physical" regions of that plane, one requires a formula yielding the value of a function inside the contour, from its values on the contour. The authors justify such method of analytic continuation by means of Cauchy's theorem. The method is illustrated by considering proton–proton scattering. J.K.Skwirzynski

539.12

9320 RANGE–ENERGY RELATION FOR VARIOUS SUBSTANCES. M.Z.Maksimov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 127-30 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 90-2 (Jan., 1960).

From an analysis of the experimental and theoretical data on the stopping of charged particles in matter, it is concluded that the specific loss and the range depend only on the ratio of E_k/a; i.e. the ratio of the incident-particle energy per nucleon, to the mean excitation potential of atoms of the medium. Proceeding from this assumption, a universal curve is plotted from the experimental data, which yields the range for energies in the interval $0.5 \leq E_k/a \leq 200$ MeV for any substance whose excitation potential is known.

539.12

9321 TRANSITION RADIATION EFFECTS IN PARTICLE ENERGY LOSSES. G.M.Garibyan.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 527-33 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 372-6 (Feb., 1960).

The energy lost by a particle that passes through a layer of matter of finite thickness is computed. It is found that at high energies the particle losses due to passage through the interface between two media (transition radiation) can become important.

539.12 : 539.18

INELASTIC COLLISIONS BETWEEN FAST POLARIZED PARTICLES AND ATOMS. See Abstr. 9751

539.12

9322 VISCOSITY IN THE HYDRODYNAMIC THEORY OF MULTIPLE PARTICLE PRODUCTION.

A.A.Emel'yanov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1550-4 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1100-2 (Nov., 1959).

The model of a viscous ultrarelativistic fluid is used to describe the dispersion of the meson—nucleon cloud produced in the collision of high-energy nucleons. An asymptotic solution of one-dimensional equations is obtained. It is shown that when viscosity is taken into account the angular distribution of secondary particles is less anisotropic than in the case of an ideal fluid.

539.12

9323 THE STATISTICAL THEORY OF MULTIPLE PRODUCTION OF PARTICLES. A.I.Nikshov.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 509-12 (Feb., 1960). In Russian.

If equilibrium does not set in during a collision one may employ the statistical theory for estimation of the mean values of the squares of the matrix elements. One may expect to obtain satisfactory agreement with experiment for the multiplicity, charge state and momentum distributions irrespective of the particle charge.

Photons

539.12

9324 DISPERSION RELATIONS FOR THE VIRTUAL COMPTON EFFECT. I.S.Zlatev and P.S.Isaev.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 728-34 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 519-23 (March, 1960).

Dispersion relations for physical amplitudes are derived by the Bogolyubov method in the centre-of-mass system for electron bremsstrahlung and for pair production by a photon in the field of a nucleon, accurate to the lowest order in e.

539.12

9325 THE FORWARD ELASTIC SCATTERING OF PHOTONS BY BOUND ELECTRONS. C.Eftimiu.

Com. Acad. R.P. Romine, Vol. 8, 153-8 (1958). (Roumanian. English and Russian summaries).

The forward scattering cross-section for the Rayleigh effect is computed by using the dispersion relation.

Mathematical Reviews

539.12 : 539.2 : 535.37

9326 ABSORPTION OF MEDIUM HIGH ENERGY GAMMA RAYS IN NaI(Tl) SCINTILLATOR.

C.Ishii, M.Kimura, Y.Ohnuki and K.Shoda.
Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 1, 7-15 (June, 1958).

Calculation of various processes of absorption of 17 MeV gamma rays passing through a NaI(Tl) oscillator are performed. The growth and decay of the gamma quanta as well as electrons and positrons of various energies are shown in diagrams, as is the spatial distribution of the sources of scintillation light emission. More than half of the light would appear to come from the layer between 20 and 65 mm from the front surface of NaI(Tl) scintillator. Build-up factors are also shown.

539.12

9327 THE PASSAGE OF GAMMA-RAYS THROUGH WATER. V.I.Kukhtevich, Yu.A.Kazanskii, Sh.S.Nikolaishvili and S.G.Tsypin.

J. nuclear Energy, Vol. 9, No. 1-4, 128-34 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 138 (1958).

The dosage attenuation in water of γ-rays from Au^{198}, Co^{60} and Na^{24} has been measured as a function of the source-detector distance over a range from some 3-4 to about 8-12 scattering mean free paths. The primary radiation was collimated in such a direction that none fell on the detector, down to an angle which was varied between 30° and 60°. Theoretical intensities have been calculated by an approximate procedure that replaces the direct solution of the kinetic equation by the reduction of a triple integral and are in satisfactory agreement with observation.

539.12 : 539.18

STUDY OF THE PHOTOELECTRIC EFFECT AND ITS APPLICATION TO THE DETERMINATION OF GAMMA-RAY INTENSITIES. See Abstr. 7688

539.12

9328 SECOND BORN APPROXIMATION TO THE BREMSSTRAHLUNG DIFFERENTIAL CROSS-SECTION.

C.Kacser.
Proc. Roy. Soc. A, Vol. 253, 103-20 (Nov. 17, 1959).

The second Born approximation contribution to the bremsstrahlung cross-section differential in both the photon and electron angles is calculated. This is divergent if a Coulomb potential is considered, but it is found, on following the idea of Dalitz (1951), that all observable quantities turn out to be finite when the calculation is performed for a Yukawa potential and the limit of zero screening is taken. It is shown that this is true to order Z^2 in the differential cross-section before it is averaged over spins, and the cross-section is calculated explicitly for the case of an unpolarized beam when the final states of polarization are not observed. Further, it is pointed out that the same methods can be applied satisfactorily in the case of pair production.

539.12

9329 POLARIZATION IN PAIR PRODUCTION BY CIRCULARLY POLARIZED QUANTA. I.G.Ivanter.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1093-7 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 777-80 (Oct., 1959).

An analysis is given of the cross-section formulae for bremsstrahlung and pair production by photons on a Coulomb centre; the formulae are derived in the Born approximation without taking into account screening and recoil and for fixed polarization of all the particles. Transformations are found which allow one to obtain some of the formulae from the others, and by means of them formulae have been derived for pair production by circularly-polarized quanta.

539.12 : 538.56

CHERENKOV RADIATION OF DIPOLES MOVING IN A CHANNEL IN A DIELECTRIC. See Abstr. 9189

X-rays

539.12

9330 RESOLVING POWER OF CURVED CRYSTAL SPECTROGRAPH. M.Suzuki.

Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 1, 1-6 (June, 1958).

In a previous paper (Abstr. 5775 of 1959) a practical method was described for the evaluation of the resolving power of a curved crystal spectrograph. As a continuation the following experiments were carried out. (i) Effects of temperature; by changing the temperature of the spectrograph, the Cu $K\alpha_1$ line shifted relative to the image of the tungsten wire, which was found to be mainly due to thermal expansion of the lattice constant of the curved quartz crystal. Consequently the temperature of spectrograph must be kept within the range ±0.37° C for the measurement of wavelength up to an accuracy of 0.01 XU. (ii) By using a Wollastone wire of diameter 10 μ instead of the tungsten wire of diameter 25 μ used in the previous experiment, the half width 18 μ of the image of the wire or $\Delta\lambda = 0.053$ XU and resolving power $\lambda/\Delta\lambda = 2.9 \times 10^4$ were obtained. When a Wollastone wire of diameter 2.5 μ is used, its image cannot be recognized on the photographic plate. (iii) As a test of the resolving power of the spectrograph, the half width of Cu $K\alpha_1$ 0.64 XU, and that of Cu $K\alpha_2$ 0.68 XU were measured.

539.12

9331 TECHNIQUE FOR OBTAINING ABSORPTION AND EMISSION SPECTRA OF X-RAYS. K, L, M,... ABSORPTION EDGES OF X-RAYS. C.Kurylenko.

Cahiers de Phys., Vol. 13, 237-56 (June, 1959). In French.

For previous work, see Abstr. 3542 of 1959; 3952 of 1960. A largely historical account of methods of obtaining absorption spectra and energies of photoelectrons. A.R.Stokes

539.12 : 537.52

X-RADIATION FROM A VACUUM SPARK. See Abstr. 9010

Neutrinos

539.12

9332 THEORETICAL DISCUSSIONS ON POSSIBLE HIGH-ENERGY NEUTRINO EXPERIMENTS.

T.D.Lee and C.N.Yang.

Phys. Rev. Letters, Vol. 4, No. 6, 307–11 (March 15, 1960).

The possible scattering and production reactions with high energy neutrinos are examined to show that they may shed light on such questions as the identity of neutrinos from β-decay and pion decay, lepton conservation, universality of weak interactions with electrons and muons, existence of a conserved vector current, existence of a weakly coupled heavy boson, and other theoretical problems in weak interactions. R.F.Peierls

539.12

9333 RESONANT SCATTERING OF ANTINEUTRINOS. S.L.Glashow.

Phys. Rev., Vol. 118, No. 1, 316–17 (April 1, 1960).

The hypothesis of an unstable charged boson to mediate muon decay radically affects the cross-section for the process $\bar{\nu} + e \rightarrow \bar{\nu} + \mu^-$ near the energy at which the intermediary may be produced. If the boson is assumed to have K-meson mass, the resonance occurs at an incident antineutrino energy of $\sim 2 \times 10^{12}$ eV. The flux of energetic antineutrinos produced in association with cosmic-ray muons will then produce two muon counts per day per square meter of detector, independently of the depth and the orientation at which the experiment is performed.

Electrons

539.12 : 539.1.07

9334 INDIVIDUAL DETECTION OF ELECTRONS (15–50 keV) IN NUCLEAR PHOTOGRAPHIC EMULSIONS. R.Wittekindt.

Z. Phys., Vol. 158, No. 5, 572–6 (1960). In German.

Ilford G5 emulsions were bombarded by a pulsed electron beam from an electron gun. The emulsions were photographed under a microscope and the tracks counted on the enlarged copies. It was found that the number of tracks per mm^2 was proportional to the number of incident electrons per mm^2. The statistics of the measurements are briefly discussed. I.C.Demetsopoullos

539.12 : 536.3

9335 RENORMALIZATION OF THE MASS OF AN ELECTRON IN A BLACK BODY. F.Englert.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 15, No. 8, 782–9 (1959). In French.

A relativistic treatment of the electron self-energy in black body radiation is developed up to the second order in the electron–photon interaction. The result defines a relativistic invariant which is an increase δm of the electron rest mass. δm is easily expressed in terms of the temperature of the black body at rest; it is however too small to be experimentally detected at usual temperatures.

539.12

9336 THE SCATTERING OF FAST CHARGED PARTICLES IV: ON THE MEASUREMENT OF THE DETOUR FACTOR FOR 10 MeV ELECTRONS AND POSITRONS. K.Phillips.

Proc. Phys. Soc., Vol. 73, Pt 6, 953–7 (June, 1959).

For Pt III see Abstr. 8149(1957). The measurements were made in G5 emulsion by counting the number of times a cell length of 40 μ could be laid off against 1 mm of track. Energy selection was made by a magnetic spectrometer. The resulting distributions agree fairly well with the theoretical calculation of Young (Abstr. 329 of 1952), and give mean values of the detour factor of about 1.02 and a skewness in the distribution of +1.8. A.Ashmore

539.12

9337 ELECTRON–ELECTRON SCATTERING AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES. G.V.Avakov.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 848–9 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 604 (March, 1960).

The cross-section for electron–electron scattering in terms of the electric and magnetic form factors is calculated and discussed. C.J.Batty

539.12

9338 MULTIPLE SCATTERING OF POLARIZED ELECTRONS. M.K.Sundaresan.

Phys. Rev., Vol. 118, No. 4, 1072–3 (May 15, 1960).

The theory of multiple scattering derived earlier (Abstr. 13016 of 1959) is used to evaluate the numerical magnitudes of the depolarization produced due to multiple scattering in gold foil of thickness 1 mg/cm^2 for polarized electrons of velocities: $\beta/c = 0.6, 0.7, 0.8, 0.9$. The depolarization effect is found to be extremely small. The correction due to multiple scattering to the electrostatic rotation of spins is also computed.

539.12

9339 POLARIZATION EFFECTS IN THE ELASTIC SCATTERING OF [POLARIZED] ELECTRONS FROM [POLARIZED] DEUTERONS. G.V.Frolov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 522–6 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 369–71 (Feb., 1960).

The differential scattering cross-section and the charge of electron polarization are calculated.

539,12 : 539.1.07

9340 MEASUREMENTS OF LOW ENERGY BETA-RAYS. T.Sidei and T.Higashimura.

J. appl. Phys. Japan, Vol. 29, No. 1, 1–11 (Jan., 1960). In Japanese.

A review of the methods of detecting and measuring beta-rays. Describes very fully, the construction and use of the following beta-particle detectors: Geiger–Müller, Libby screen wall counter, 2π flow counter, cylindrical gas counter, ionization chamber, plastic scintillation counters (of various geometries), liquid scintillation counter, and diffusion cloud chamber. All tables, and thirty-eight references, are in English.

539.12

9341 USE OF A LIQUID SCINTILLATOR COUNTER FOR BETA PARTICLES. T.B.Ryves.

J. sci. Instrum., Vol. 37, No. 6, 201–3 (June, 1960).

A simple counting technique is decribed for absolute counting of beta particles using a 4π liquid scintillator counter technique. The radioactive sample is deposited on a thin backing film of transparent material, which is then immersed in the liquid scintillator. It was found that for samples with a maximum beta particle energy greater than 0.7 MeV the detection efficiency was close to 100% comparing favourably with other methods of absolute counting.

539.12

9342 MEAN LIVES OF POSITRONS IN ALUMINUM AND THE ALKALI METALS. R.E.Bell and M.H.Jørgensen.

Canad. J. Phys., Vol. 38, No. 5, 652–64 (May, 1960).

The time distribution of positron annihilations in the metals aluminium, lithium, sodium, potassium, and caesium have been measured with a fast time-to-amplitude converter. The decay curves appear to be complex, with about 5% of the events having a mean life of approximately 5×10^{-10} sec. The main (95%) components of the decay curves show the following mean lives, in units of 10^{-10} sec: Al, 1.9 ± 0.2; Li, 2.9 ± 0.2; Na, 3.15 ± 0.2; K, 4.0 ± 0.2; Cs, 4.3 ± 0.2. The results for the alkali metals disagree with the previously published measurements of De Benedetti and Richings (Abstr. 3844 of 1952). These results are discussed, and the lifetimes for other metals are predicted roughly from them and from the angular correlation measurements of other workers.

539.12 : 532.7

9343 POSITRON ANNIHILATION IN AQUEOUS SOLUTIONS. G.Trumpy.

Phys. Rev., Vol. 118, No. 3, 668–74 (May 1, 1960).

The angular correlation of 2-quantum emission from the annihilation of positrons in different materials was measured in an apparatus with 8 photon counters providing coincidences for 16 output channels. As positron targets were chosen indium, water and aqueous solutions of 5 paramagnetic salts and 10 other substances. It was confirmed that the amount of singlet positronium formed is influenced by two processes : a reduction of positronium due to

electron capture by oxidizing substances and an increase of the triplet → singlet conversion due to the electron exchange with paramagnetic ions. The oxidation potential of positronium is found to be very nearly zero. The conversion rate seems to be proportional to the number of unpaired electrons on the dissolved ions. A discrepancy with the interpretation of Green and Bell (Abstr. 2583 of 1959; 8144 of 1957) for their lifetime experiments is discussed.

539.12

9344 DIRECT PRODUCTION OF ELECTRON–POSITRON PAIRS BY HIGH-ENERGY ELECTRONS.

V.A.Tumanyan, G.S.Stolyarova and A.P.Mishakova.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 355-65 (Aug., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 253-60 (Feb., 1960).

The absolute number of spurious tridents for 10^{10}, 10^{11}, and 10^{12} eV primary electrons is computed by the Monte Carlo method for two types of the bremsstrahlung spectrum: the one given by the Bethe–Hietler formula and that described by the Migdal formulae, which take into account the Landau–Pomeranchuk and the Ter–Mikaelyan effects. It is shown that it is feasible to measure the energy of fast electrons by determining the energy dependence of the mean transverse distance between the vertices of electron-positron pairs produced by bremsstrahlung γ-quanta. The value of the cross-section for the direct production of electron–positron pairs calculated by Bhabha is confirmed experimentally.

539.12

9345 PAIR PRODUCTION IN COLLISIONS BETWEEN CHARGED PARTICLES. F.F.Ternovskii.

Zh. eksper. teor. Fiz., Vol. 37 No. 3(9), 793-8 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 565-9 (March, 1960).

Pair production due to collisions between fast charged particles and atoms is considered. Expressions for the cross-sections are obtained which are valid for positron and electron energies comparable with that of the parent particle.

539.12

9346 RADIATIVE CORRECTIONS TO PHOTOPRODUCTION AND SINGLE-PHOTON ANNIHILATION OF PAIRS.

S.Ya.Guzenko and P.I.Fomin.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 513-17 (Feb., 1960). In Russian.

General formulae are obtained for radiative corrections to photoproduction and single-photon annihilation of electron–positron pairs. Some limiting cases are considered.

Nucleons

539.12

9347 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. A.M.Bincer.

Phys. Rev., Vol. 118, No. 3, 855-63 (May 1, 1960).

Dispersion relations are proved for the electromagnetic and mesonic nucleon vertix functions considered as a function of the nucleon mass. The results are used to express the isotopic scalar and the isotopic vector electromagnetic form factors of the nucleon in terms of pion electroproduction (or photoproduction) and pion–nucleon scattering amplitudes in the $J = \frac{1}{2}$, $T = \frac{1}{2}$ state.

539.12 : 537.54

COHERENT ELECTRON RADIATION IN A SYNCHROTRON.
See Abstr. 9124

539.12 : 539.14

9348 A POSSIBILITY OF INVESTIGATION OF THE STRUCTURE OF NUCLEONS AND NUCLEI.

N.G.Birger and Yu.A.Smorodin.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11). 1355-60 (Nov., 1959).
In Russian.

It is shown that in the interaction of high-energy particles the sum of the quantities $(E-p\cos\theta)$ for all particles emitted after the interaction is equal to the mass of the target particle which effectively participates in the interaction. Thus the distribution of $\Sigma(E-p\cos\theta)$ is specified by the structure of the target particle. Application of this type of analysis to the experimental data on nucleon–nucleon interactions shows that interactions with the part of the target possessing mass close to that of the π-meson are dominant.

539.12

9349 THE ANOMALOUS MAGNETIC MOMENT OF NUCLEONS IN CHEW'S METHOD.

Yu.M.Lomsadze, V.I.Lend'el and B.M.Érnst.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1342-5 (Nov., 1959).
In Russian.

Corrected values of nucleon magnetic moments due to π-meson and nucleon virtual currents were obtained by Chew's method. Allowance for the contribution of strange particles and of the hypothetical ρ^0-meson is made under various assumptions regarding their intrinsic parities.

539.12

9350 MOMENTUM DISTRIBUTION OF PARTICLES CREATED IN INELASTIC N–N COLLISIONS AT 9 BeV.

V.S.Barashenkov, Van-Pei [Wang P'ei] and V.M.Mal'tsev.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 650-2 (Feb., 1960). In Russian.

The pions tend to have lower momenta, the nucleons greater, than predicted by the statistical theory. The fraction of initial energy going into particle creation is lower than the predicted 58%. These deviations from the statistical theory could be explained by considering peripheral as well as central collisions of the nucleons.

D.W.L.Sprung

539.12

9351 NUCLEON–NUCLEON SCATTERING IN TWO-MESON APPROXIMATION AT LARGE ORBITAL MOMENTA.

A.D.Galanin, A.F.Grashin, B.L.Ioffe and I.Ya.Pomeranchuk.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 475-88 (Feb., 1960).
In Russian.

The method developed by the authors earlier (Abstr. 7343 of 1960) is used to calculate the nucleon–nucleon scattering amplitude in two-meson approximation at large orbital momenta. Calculations are carried out for singlet amplitude in non-relativistic approximation at orbital momenta that are not very great, $1 \ll l \ll 4m^2/\mu^2$ (m = nucleon mass, μ = meson mass). The results obtained indicate that F and G phases with nucleon energies $E_{lab} < \sim 200$ MeV can be derived with good accuracy from the one-meson approximation. This conclusion may prove important for the phase analysis of nucleon scattering.

539.12

9352 THE ELASTIC SCATTERING OF NUCLEONS BY TRITONS AND ^{3}He.

B.H.Bransden, R.A.H.Hamilton and H.H. Robertson.
Proc. Phys. Soc., Vol. 75, Pt 1, 144-7 (Jan., 1960).

Calculations are made for incident protons and neutrons in the energy range 5-20 MeV using a Gaussian potential of the Serber type. The results are compared with experimental data at these energies.

C.J.Batty

Protons

539.12

9353 THE EXCITATION OF THE 4.43 MeV LEVEL OF C^{12} BY PROTONS OF ABOUT 100 MeV.

P.Benoist, C.Marty and P.Meyer.
J. Phys. Radium, Vol. 19, No. 1, 11-12 (Jan., 1958). In French.

The angular distribution of inelastically scattered protons has been calculated assuming for the reaction a direct interaction process (a) by Born approximation, (b) by taking into account the distortion of the incoming and outgoing proton waves by a complex potential.

539.12

9354 INTERACTION OF 9 BeV PROTONS WITH FREE AND QUASI-FREE NUCLEONS IN PHOTOGRAPHIC EMULSIONS. N.P.Bogachev, S.A.Bunyatov, I.M.Gramenitskii, V.B.Lyubimov, Yu.P.Merekov, M.I.Podgoretskii, V.M.Sidorov and D.Tuvdendorzh.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1225-32 (Nov., 1959).
In Russian.

The problem of the angular and energy characteristics of secondary particles produced in the collisions between protons and nucleons is considered.

539.12

9355 **CHARGE INDEPENDENCE IN THE REACTIONS $p + d \rightarrow \pi^0 + He^3$ AND $p + d \rightarrow \pi^+ + H^3$ AT 450 MeV.**
A.V.Crewe, B.Ledley, E.Lillethun, S.M.Marcowitz and C.Rey.
Phys. Rev., Vol. 118, No. 4, 1091-4 (May 15, 1960).

The branching ratio in the production of He^3 and H^3 in p–d collisions at 450 Mev at 140° in the c.m. system was determined as 2.13 ± 0.15, which is in agreement with the prediction of a ratio 2 on the basis of charge independence alone. The production cross-sections were found to be $(d\sigma/d\Omega)_{He^3} = 5.41 \pm 0.29$ μb/sr and $(d\sigma/d\Omega)_{H^3} = 11.55 \pm 0.49$ μb/sr.

539.12

9356 **PROTON–DEUTERON INTERACTIONS AT 970 MeV.**
A.P.Batson, B.B.Culwick, H.B.Klepp and L.Riddiford.
Proc. Roy. Soc. A, Vol. 251, 233-46 (May 26, 1959).

See also Abstr. 1279-80 (1960). A high-pressure diffusion cloud chamber was used to study the interactions of 970 MeV protons from the Birmingham synchrotron with deuterium. Analysis of the 569 collisions observed indicates that at this energy the deuteron behaves as if it were composed of two free nucleons. The properties of proton–proton and proton–neutron scattering were determined on this assumption. An estimate is made of the extent of the "shadowing" of each nucleon in the deuteron by the other. The partial cross-sections for p–p and p–n elastic scattering were determined, as have also the values for the five possible single meson production processes. They have the following "best" values:

(1) $(p + p \rightarrow p + p) = 25.9 \pm 1.7$ mb,
(2) $(p + n \rightarrow p + n) = 16.2 \pm 3.5$ mb,
(3) $(p + p \rightarrow p + p + \pi^0) = 5.4 \pm 1.0$ mb,
(4) $(p + p \rightarrow n + p + \pi^+) = 15.6 \pm 1.7$ mb,
(5) $(p + n \rightarrow p + n + \pi^0) = 14.3 \pm 3.5$ mb,
(6) $(p + n \rightarrow p + p + \pi^-) = 2.7 \pm 0.6$ mb,
(7) $(p + n \rightarrow n + n + \pi^+) = 4.3 \pm 1.1$ mb.

Double meson production and reactions involving secondary deuterons are not important. The cross-sections (1), (2), (3), (4) and (5) are consistent with values extrapolated from data at energies below 660 MeV by Russian workers. Knowledge of the other cross-sections (6) and (7) makes possible a test of the validity of the charge independence of nuclear forces. The present results are not in good agreement with this. The results for inelastic scattering indicate that, assuming charge independence, the formation of excited nucleons of isotopic spin $\frac{3}{2}$ does not dominate the process of pion production. This is also true for the Russian data. Twelve cases of double meson production were observed. The angular distribution of proton–neutron elastic scattering has the form expected from lower energy data.

539.12

9357 **MEASUREMENT OF THE POLARIZATION OF DEUTERONS IN THE REACTION $p + p \rightarrow d + \pi^+$ AT PROTON ENERGIES OF 670 MeV.**
Yu.K.Akimov, K.S.Marish, O.V.Savchenko and L.M.Soroko.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 46-53 (July, 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 33-8 (Jan., 1960).

The spin polarization of deuterons was measured at three angles, 121°, 140°30' and 162°, in the c.m.s. The nonresonant p-transition $^1S_0 \rightarrow {}^3S_1p_0$ was found. The contribution of this transition to the total cross-section is about 1%. The measured angular dependence of the spin polarization does not contradict the assumption that the transition amplitudes from the initial two-proton states $^3F_3$ and $^1F_3$ are equal to zero.

539.12

9358 **THE RESONANT SCATTERING INTEGRAL; APPLICATION TO THE ANALYSIS OF ELASTIC PROTON SCATTERING.**
P.B.Smith.
Physica, Vol. 24, No. 12, 1085-91 (Dec., 1958).

A relationship is presented which permits a determination of the quantity Γ_p^2/Γ, where Γ_p and Γ are the particle (proton) and total widths, respectively, of an isolated resonance of which the total spin and channel spin mixing parameters are known. The form of the integral is familiar in several fields of physics and has proved useful before. In resonances where only capture and elastic scattering can occur, unique values of the radiation width and the particle width can be obtained from Γ_p^2/Γ, together with the familiar radiation strength $\Gamma_p\Gamma_\gamma/\Gamma$.

539.12

9359 **[ELASTIC] SCATTERING OF 5-10 MeV PROTONS ON He^3.** K.P.Artemov, S.P.Kalinin and L.N.Samoilov.
Zh. eksper. teor. Phys., Vol. 37, No. 3(9), 663-6 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 474-6 (March, 1960).

The angular distribution of the protons was measured for five values of the incident energy. The protons were recorded by their tracks in photographic plates. The differential cross-sections so obtained are compared with theoretical values calculated under two different assumptions regarding the character of the exchange force. The nucleon–nucleon interaction with Serber exchange forces is in better agreement with the experiment results. The energy dependence of the cross-section does not reveal the discrete levels in the Li^4 nucleus.

539.12

9360 **RANGE–ENERGY RELATIONS FOR PROTONS IN VARIOUS SUBSTANCES.** R.M.Sternheimer.
Phys. Rev., Vol. 118, No. 4, 1045-8 (May 15, 1960).

An expression is obtained for the range–energy relation $R(T_p)$ for protons (T_p = proton kinetic energy) as a function of the mean excitation potential I which enters into the Bethe–Bloch formula for the ionization loss dE/dx. The expression for $R(T_p)$ is obtained by an interpolation of the previously calculated range-energy relations for Be, Al, Cu, and Pb (Abstr. 12556 of 1959). The resulting expression for $R(T_p)$ can be used for any substance, provided an appropriate value of I is assumed. Values are also obtained for the quantity $q = (I/R)(dR/dI)$ which gives the fractional change of R for a small variation of the excitation potential I.

539.12

9361 **PROTON POLARIZATION IN p–d SCATTERING.**
S.M.Shafroth, R.A.Chalmers, E.N.Strait and R.E.Segel.
Phys. Rev., Vol. 118, No. 4, 1054-9 (May 15, 1960).

The proton polarization resulting from photon–deuteron elastic scattering was measured in a double-scattering experiment. The first scattering took place in helium, which served as a polarizer, and the left-right asymmetry observed in a second scattering in deuterium. Spurious asymmetries were checked by substituting xenon and, separately, helium for deuterium as the second scatterer. Measurements taken at a proton–deuteron energy of $E_p = 3.4$ MeV, $\theta = 45°$ all yielded results consistent with no polarization. From these data it is concluded that the proton polarization in p–d elastic scattering is $< \sim 10\%$ in this energy region.

539.12

9362 **POLARIZATION OF NEUTRONS FROM THE $T(p,n)He^3$ REACTION AND PROTONS FROM THE $He^3(n,p)T$ REACTION.** K.P.Artemov, N.A.Vlasov and L.N.Samoilov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1183-6 (Nov., 1959).
In Russian.

Polarization of neutrons produced in the $T(p,n)He^3$ reaction by 8–10 MeV protons was determined by measuring the right–left asymmetry of protons produced in the inverse reaction $He^3(n,p)T$. Dependence of the asymmetry on the angle of emission of the proton in the $He^3(n,p)T$ reaction was also measured. Polarization of the $T(p,n)He^3$ neutrons and $He^3(n,p)T$ protons reaches 30% for an angle of incidence of about 40° and a primary proton energy of approximately 10 MeV. With decrease of the proton energy the polarization decreases but the angle of emission corresponding to peak polarization does not change appreciably.

539.12 : 537.54

9363 **ACCELERATION OF POLARISED PROTONS WITH STRONG-FOCUSING LINEAR ACCELERATORS.**
D.Cohen and A.J.Burger.
Rev. sci. Instrum., Vol. 30, No. 12, 1134-5 (Dec., 1959).

With a view to producing a polarized proton beam from source polarized accelerated particles the precession of the magnetic moment was calculated during the passage through a linear accelerator. The computations were done for an accelerator with quadrupoles within each of the 124 drift sections similar to the Brookhaven AGS injector. The deviations from the direction of the magnetic moment at injection are never larger than 10 deg. This is due to precession cancellation between successive magnets of opposite polarity. In fact the resulting total deviation may not be larger than 3 deg.
H.Motz

539.12

9364 A 2.8 BeV/c MOMENTUM ANTIPROTON CHANNEL. N.M.Viryasov, A.S.Vovenko, G.G.Vorob'ev, A.D.Kirillov, Kim Khi In, B.A.Kulakov, A.L.Lubimov, Yu.A.Matulenko, I.A.Savin, E.V.Smirnov, L.Strunov and I.V.Chuvilo.
Zh. eksper. teor Fiz., Vol. 38, No. 2, 445-8 (Feb., 1960).
In Russian.

An arrangement for separation of antiprotons possessing a momentum of 218 GeV/c obtained from the Joint Institute for Nuclear Research proton synchrotron is described. Data on the relative frequency of generation of antiproton and π-mesons in Be and Cu were obtained.

Neutrons

539.12 : 532.7 : 539.2

SOLID AND LIQUID STATE RESEARCH WITH COLD NEUTRONS. See Abstr. 7840

539.12

9365 NEUTRON FORM FACTORS FROM HIGH-ENERGY INELASTIC ELECTRON–DEUTERON SCATTERING. S.Sobottka.
Phys. Rev., Vol. 118, No. 3, 831-8 (May 1, 1960).

The inelastic electron–deuteron scattering cross-section was measured for incident electron energies between 300 and 650 MeV and for final electron energies primarily at the maxima of the inelastic continua. The data were interpreted in terms of neutron form factors by employing the impulse approximation calculations of Goldberg (Abstr. 3898 of 1959). The results indicate that F_{sn}^2 is nearly equal to the proton form factor F_p^2 for $2.65 < q^2 < 15.1$ (fermi)$^{-2}$ but may be 20 or 30% higher than F_p^2 for the lowest of these q values. Uncertainties, primarily in the theory, make it impossible to determine whether the difference is real. The results also indicate that $-2.5 < F_{in}/F_{sn} < 0.5$ for $5.1 < q^2 < 12.8\,f^{-2}$.

539.12

9366 SPACE-TIME CORRELATION FUNCTION FORMALISM FOR SLOW NEUTRON SCATTERING. P.Schofield.
Phys. Rev. Letters, Vol. 4, No. 5, 239-40 (March 1, 1960).

Suggests a way to approximate the cross-section for coherent scattering from an assembly of atoms, using the classical correlation function; it is correct to first order in ħ and satisfies detailed balance. Also exhibits a dispersion relation for the correlation function. R.J.N.Phillips

539.12

9367 MEASUREMENT OF THE ANGULAR DISTRIBUTION OF NEUTRONS ELASTICALLY SCATTERED BY He^3. A.I.Abramov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1476-8 (Nov., 1959).
In Russian.

This was carried out by measuring the energy distribution of the recoil nuclei. Contributions from the reaction $He^3(n,p)T$ were subtracted graphically from the measured spectra; the shape of these contributions was measured using thermal neutrons. The deduced angular distributions at 1000, 2770 and 4480 keV are compared with calculations based on central forces, symmetric and Serber mixtures. The results presented appear to extend to $\cos\theta = -1.2$. D.W.L.Sprung

539.12

9368 EFFECTIVE BOUNDARY CONDITIONS IN THE THEORY OF NEUTRON DIFFUSION (A REVIEW). G.A.Bat' and D.F.Zaretskii.
J. nuclear Energy, Vol. 9, No. 1-4, 252-66 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 510 (1958).

This review describes methods for determining effective boundary conditions (EBC) which ensure that in the asymptotic region a solution of the neutron diffusion equation coincides with the solution of the corresponding transport equation. The EBC for mono-energetic neutrons on plane and on cylindrical surfaces of "black" and of "grey" bodies are discussed. Results are given for EBC in the case of cylinders of arbitrary section. The simplest problem of EBC determination for neutrons moderated in a medium of heavy atoms and with a scattering cross-section not dependent on energy is considered. The review includes results obtained by workers both in the U.S.S.R. and elsewhere.

539.12

9369 ON A TIME OF FLIGHT METHOD OF STUDYING THE VELOCITY DISTRIBUTION OF NEUTRONS FROM DIFFUSING MEDIA. V.C.Deniz, S.B.D.Iyengar and R.Ramanna.
Proc. Indian Acad. Sci. A, Vol. 45, No. 4, 205-14 (April, 1957).

The theory is given for the velocity distribution of neutrons at a point outside a diffusing medium, following a burst of fast neutrons at a time such that slowing down is complete. Corrections are given for the finite area of emission of the neutrons and their anisotropic angular distribution. Experimental results are given for two sizes of BeO stacks. These agree with the most probable neutron velocities inside the stack, as obtained from measurements of the diffusion cooling constant. The spectra show appreciable time of flight cooling. A.Ashmore

539.12

9370 A CALCULATION OF THE NEUTRON ENERGY SPECTRUM PRODUCED BY A PULSED SOURCE IN A HEAVY MODERATOR, ASSUMING A CONSTANT MEAN FREE PATH. M.V.Kazarnovskii.
J. nuclear Energy, Vol. 9, No. 1-4, 293-303 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 539 (1958).

The energy distribution of neutrons from a pulsed source in a moderator of mass number $M \gg 1$ is shown, on the assumption of a constant mean free path l, to be

$$n(z) = \text{const.} \times \exp\{\tfrac{1}{2}(M+1)f_{-1}(z) + f_0(z) + 2(M+1)^{-1}f_1(z) + \ldots\}$$

at energies small in comparison with the source energy. $z = l(M+1)/vt$, with v the neutron velocity and t the slowing-down time. $f_{-1}(z)$, $f_0(z)$ and $f_1(z)$ are given in integral form, together with analytical expressions valid near the maximum, and asymptotic expansions; detailed tables of the functions are also provided. It is demonstrated by numerical calculations that a knowledge of these three functions is sufficient to allow the neutron spectrum to be determined even in deuterium. The situation in a moderator composed of a number of different types of nuclei is considered. In this case the problem is solved by developing a method for solving integral and integrodifferential equations whose kernel $K(x,y)$ is significantly different from zero only where $|x-y|/|x+y|$ is very small.

539.12

9371 FLUX PERTURBATION BY DETECTOR FOILS. A.Sola.
Nucleonics, Vol. 18, No. 3, 78-81, 141 (March, 1960).

Measurements were made of the flux depressions caused by small circular gold foils. The radii of the foils varied from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. and the thicknesses from 1 to 20 mils. The results are compared with correction factors based on theories due to Skyrme and Bothe. Both corrections are accurate for foils up to 5 mils thick. For thicker foils Bothe's theory fits the experimental results better. R.D.Smith

539.12

9372 NEUTRON-ABSORPTION ALIGNMENT CHART. R.G.Nisle.
Nucleonics, Vol. 18, No. 3, 86-8 (March, 1960).

Nucleonics data sheet No. 36. A nomogram enabling the attenuation of neutrons passing through a foil, and hence the flux depression in the foil, to be calculated from the microscopic cross-section. The accuracy is about 5%. R.D.Smith

539.12

9373 RESONANCE ABSORPTION OF NEUTRONS IN AN INFINITE HOMOGENEOUS MEDIUM. G.I.Marchuk and F.F.Mikhailus.
J. nuclear Energy, Vol. 9, No. 1-4, 267-80 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 520 (1958).

A study of the problem of the slowing down of neutrons in an infinite homogeneous medium with strong resonance absorption and uniformly distributed neutron sources. The solution of the adjoint equation gives the probability that a neutron of energy E escapes resonance capture during the process of moderation down to a certain limiting energy. The solutions of the original and the adjoint problem enable one to use a perturbation functional to take into account the influence of Doppler broadening of the resonance level in the resonance integral. The methods developed are applied to the calculation of the collision density and the resonance integrals for the first level of U^{238}($E_0 = 6.7$ eV) in pure uranium and in UO_2.

539.12

9374 SLOWING DOWN AND DIFFUSION OF NEUTRONS IN BERYLLIUM OXIDE.

S.B.D.Iyengar, G.S.Mani, R.Ramanna and N.Umakanth.

Proc. Indian Acad. Sci. A, Vol. 45, No. 4, 215-23 (April, 1957).

The theory is given which enables the constants of a moderator to be deduced from measurements on the decay rate of thermal neutron density, in assemblies ranging in size, following a burst of fast neutrons. Results are given for BeO using fifteen assembly sizes, and compared with earlier results for other moderators.

A.Ashmore

539.12

9375 TEMPERATURE DEPENDENCE OF THE SLOWING DOWN AND DIFFUSION CONSTANTS OF NEUTRONS IN BERYLLIUM OXIDE.

S.B.D.Iyengar, G.S.Mani, R.Ramanna and N.Umakanth.

Proc. Indian Acad. Sci. A, Vol. 45, No. 4, 224-30 (April, 1957).

The BeO stack was heated in an electric furnace, precautions being taken to prevent escaping neutrons being reflected back into the stack. Observations were made of the decay in thermal neutron intensity following a burst of fast neutrons. Values are given for the diffusion coefficient and diffusion cooling constant at 297°, 353° and 413° K, and values of the relaxation time are deduced from them. Graphs are given for the variation of equilibrium temperature and diffusion cooling constant with stack temperature. The latter graph indicates a decrease of the heat transfer coefficient with increasing temperature, contrary to the Debye model.

A.Ashmore

539.12

9376 POLARIZATION OF d–d NEUTRONS.

P.S.Otstavnov.

Zh. eksper. teor. Fiz., Vol. 37, No. 6 (12), 1815-17 (Dec., 1959). In Russian.

Simultaneous energy and polarization measurements, using a standard detector–analyser system, were made on d–d neutrons. The polarization was found to increase monotonically from about 3% at 0.35 MeV to about 15% at neutron energies around 1 MeV.

J.W.Gardner

539.12

9377 THE STATUS OF THE CANADIAN NEUTRON STANDARD.

K.W.Geiger.

Canad. J. Phys., Vol. 38, No. 4, 569-72 (April, 1960).

A report of comparisons with standard neutron sources in Sweden, Belguim, Germany, Britain and U.S.A.

R.J.N:Phillips

539.12

9378 THE HARWELL NEUTRON PROJECT.

M.J.Poole and E.R.Rae.

Nature (London), Vol. 185, 280 (Jan. 30, 1960).

The facilities now available at Harwell for low-energy neutron time-of-flight experiments are described. Using the 30 MeV electron linear accelerator and a target of natural uranium, a rate of emission during the beam pulse of 2×10^{16} neutrons/sec is obtainable. The pulse length can be as short as 0.25 μsec. Using a subcritical U^{235} assembly as booster, the neutron yield can be increased to 3×10^{17} neutrons/sec in the pulse. After partial moderation in flat water tanks, the neutrons pass through a set of radiating evacuated flight tubes to the detecting and time-sorting equipment. The apparatus is suitable for measurements of the total, scattering, capture and fission cross-sections of neutrons as a function of energy, and for measurements on γ-rays following neutron capture. It can also be used for examination of the neutron spectra following moderation in various materials and for measurements on the last stages of the slowing-down process itself.

R.E.Meads

539.12

9379 A MECHANICAL SLOW-NEUTRON SELECTOR.

B.Jacrot and G.Gobert.

J. Phys. Radium, Vol. 19, No. 1, 62 (Jan., 1958). In French.

Selection is by time-of-flight between two wheels.

539.12

9380 A MECHANICAL SELECTOR TO ELIMINATE INTERFERENCE DUE TO HIGHER ORDER DIFFRACTIONS IN A CRYSTAL SPECTROMETER.

P.Hubert, R.Joly and G.Signarbieux.

J. Phys. Radium, Vol. 19, No. 1, 79-81 (Jan., 1958). In French.

A mechanical velocity selector has been designed and constructed for use with a neutron crystal spectrometer, to remove the higher order coherently scattered neutrons. Total cross-sections of neodymium, iridium and thorium were measured with this equipment.

539.12

9381 NEVIS SYNCHROCYLOTRON SLOW NEUTRON VELOCITY SPECTROMETER. J.Rainwater, W.W.Havens, Jr, J.S.Desjardins and J.L.Rosen.

Rev. sci. Instrum., Vol. 31, No. 5, 481-9 (May, 1960).

A high-intensity, high-resolution neutron velocity selector system, employing the Nevis synchrocyclotron as a source of pulsed neutrons, is described. Detector counts are accumulated in a 2000 channel analyser with 0.1 μsec channel width. Punch card data reduction techniques are discussed. Resonance spectra of PbI_2 obtained using a 35 m flight path provide an example of the resolution and illustrate the use of the self-indication capture γ-ray detector scheme extensively employed. A planned flight path of 200 m is expected to provide a resolution of < 1 nsec/m for neutron energies above 1000 eV.

539.12

9382 A 2000-CHANNEL ANALYZER FOR NEUTRON SPECTROSCOPY. J.Hahn and W.W.Havens, Jr.

Rev. sci. Instrum., Vol. 31, No. 5, 490-500 (May, 1960).

A 2000 channel time-of-flight analyser for neutron spectroscopy is described. The analyser is designed for use with pulsed accelerators operating at approximately 60 c/s. Channel widths of 0.1 μsec and a dead time of 0.8 μsec are obtained. A fast electrostatic memory is used to record data with a minimum of dead time, and a slower larger capacity magnetic drum memory is used to read out the electrostatic memory and accumulate data between bursts. The electrostatic memory system which was developed at Columbia University is described in detail.

539.12

9383 A TIME-OF-FLIGHT SELECTOR FOR FAST NEUTRONS.

E.Remy and K.Winter.

J. Phys. Radium, Vol. 19, No. 1, 96-7 (Jan., 1958). In French.

A fast coincidence circuit and time-sorter is described, designed for time-of-flight measurements of fast neutrons. The zero-time is established by the associated particle method.

539.12

9384 NEUTRON DETECTOR FOR REACTOR CONTROL.

T.Adachi.

J. appl. Phys. Japan, Vol. 29, No. 1, 32-40 (Jan., 1960). In Japanese.

A parallel circular plate type ionization chamber (PCP) and a gamma-ray compensated ionization chamber (CIC) to be used for reactor control were constructed with materials that are small in neutron absorption cross-section and induced activity and are also radiation- and high temperature-resistive checked by activation analysis. Enriched 96% B imported from ORNL, U.S.A. was used. During the preparatory work, techniques for the fine machining of reactor grade graphite, arc welding of magnesium in argon, and boron coating were developed. Neutron sensitivity, γ-ray sensitivity, linearity, and induced activity of six kinds of neutron detectors including the author's PCP and CIC and one that was imported were tested using the JRR-I reactor and γ-ray sources of 10 kc and 1 kc Co^{60}. Results of the tests show that the detectors constructed were not only as good as the imported but superior to it as regards the residual activity.

539.12

9385 THE USE OF A GAMMA-RAY POCKET DOSIMETER FOR FAST-NEUTRON DOSIMETRY.

V.V.Bovin and A.I.Mosharov.

J. nuclear Energy, Vol. 5, No. 3-4, 427-8 (1957). English translation of article in: Atomnaya Energiya, Vol. 2, 184 (1957).

The dosimeter was used near Be and Cu targets bombarded by 8-13 MeV deuterons from a cyclotron. In the first case neutrons accounted for 80%, in the second for 16% of the ionization. Its sensitivity was such that 6.5×10^8 fast neutrons/cm² corresponded to a reading of 25 mr ± 6%, the total error not exceeding 32% of which 26% was that in determining the neutron flux from the source. Self-discharge due to electrical leakage corresponded to a dose of 10-20 mr/month in the charged state.

I.C.Demetsopoullos

539.12 : 537.534

NEUTRON PULSE PRODUCTION. See Abstr. 9100

Mesons

539.12

9386 THE MASS SPECTRUM OF MESONS IN HEISENBERG'S THEORY. Ya.I.Granovskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1154-8 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 819-22 (Oct., 1959).

The mass spectrum is computed. The comparison of the results with the experimental data indicates that the scalar version of the nonlinear term leads to the best agreement in the first approximation of the Tamm–Dancoff method.

539.12

9387 PATHOLOGICAL BOUND STATES IN THE BOSCO–STROFFOLINI MODEL OF THE MESON–NUCLEON INTERACTION. M.Pécheux.
Cahiers de Phys., Vol. 12, No. 91, 110-28 (March, 1958). In French.

Studies the appearance of "ghost states", with negative norm, in this model (Abstr. 9435 of 1955). R.J.N.Phillips

539.12 : 539.11

DISPERSION RELATIONS AND CHEW–LOW TYPE EQUATIONS FOR INELASTIC MESON PROCESSES IN THE FIXED SOURCE CASE. See Abstr. 9299

539.12

9388 MUON DECAY IN NUCLEAR EMULSION AT 25 000 GAUSS. G.R.Lynch, J.Orear and S.Rosendorff.
Phys. Rev., Vol. 118, No. 1, 284-91 (April 1, 1960).

Positive pions from the 90 MeV pion beam of the Nevis cyclotron were stopped in nuclear emulsion which was in a magnetic field of 25 000 G. The asymmetry parameter for the angular distribution of the positrons which came from the decay muons was measured. The result that $P\xi = -0.87 \pm 0.04$ implies that either the asymmetry parameter ξ is different from the value of -1 predicted by the V-A theory or that there is about 13% depolarization of positive muons in nuclear emulsion at 25 000 G.

539.12

9389 FURTHER SEARCH FOR THE DECAY $\mu^+ \to e^+ + \gamma$. S.Frankel, V.Hagopian, J.Halpern and A.L.Whetstone.
Phys. Rev., Vol. 118, No. 2, 589-90 (April 15, 1960).

A new experiment for determining the upper limit for the branching ratio R of the process $\mu^+ \to e^+ + \gamma$ relative to the normal decay mode $\mu^+ \to e^+ + \nu + \bar{\nu}$ yields a value of R of less than 1.2×10^{-6} with a 90% confidence level.

539.12

9390 SEARCH FOR RARE DECAY MODES OF THE μ^+ MESON. J.Lee and N.P.Samios.
Phys. Rev. Letters, Vol. 3, No. 1, 55-6 (July 1, 1959).

The possible existence of the decay modes $\mu^+ \to e^+ + e^- + e^+$ and $\mu^+ \to e^+ + e^- + e^+ + \nu + \bar{\nu}$ was investigated by examining the decays of 2.2×10^5 positive muons in a hydrogen bubble chamber with a magnetic field of 8800 G. Three events were found in which three charged prongs emerged from the muon ending. All showed an unbalance of momentum and were attributed to the second decay mode, whose branching ratio is

$$R' = (\mu^+ \to 2e^+ + e^- + \nu + \bar{\nu})/(\mu^+ \to e^+ + \nu + \bar{\nu}) = (1.5 \pm 1) \times 10^{-5},$$

compared with a theoretical prediction of 5×10^{-5}. The absence of the decay into three electrons set the upper limit for the branching ratio

$$R = (\mu \to 2e^+ + e^-)/(\mu^+ \to e^+ + \nu + \bar{\nu}) = 1 \times 10^{-6}$$

with 90% confidence. E.G.Michaelis

539.12

9391 LOW ENERGY POSITRONS FROM THE $\mu^+ - e^+$ DECAY. A.O.Vaisenberg.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1019-21 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 722-3 (Oct., 1959).

The value $\rho = 0.72 \pm 0.10$ was obtained for the Michel parameter by analysing available data on the spectrum of low-energy positrons emitted in $\mu^+ - e^+$ decays in photographic emulsions.

539.12

9392 ACCURATE DETERMINATION OF THE μ^+ MAGNETIC MOMENT.
R.L.Garwin, D.P.Hutchinson, S.Penman and G.Shapiro.
Phys. Rev., Vol. 118, No. 1, 271-83 (April 1, 1960).

Using a precession technique, the magnetic moment of the μ^+-meson is determined to an accuracy of 0.007%. Muons are brought to rest in a bromoform target situated in a homogeneous magnetic field, oriented at right angles to the initial muon spin direction. The precession of the spin about the field direction, together with the asymmetric decay of the muon, produces a periodic time variation in the probability distribution of electrons emitted in a fixed laboratory direction. The period of this variation is compared with that of a reference oscillator by means of phase measurements of the "beat note" between the two. The magnetic field at which the precession and reference frequencies coincide is measured with reference to a proton nuclear magnetic resonance magnetometer. The ratio of the muon precession frequency to that of the proton in the same magnetic field is thus determined to be 3.1834 ± 0.0002. Using a re-evaluated lower limit to the muon mass, this is shown to yield a lower limit on the muon g factor of $2(1.00122 \pm 0.00008)$, in agreement with the predictions of quantum electrodynamics.

539.12

9393 SEARCH FOR AN ELECTRIC DIPOLE MOMENT STRUCTURE OF THE MUON. D.Berley and G.Gidal.
Phys. Rev., Vol. 118, No. 4, 1086-91 (May 15, 1960).

A search was made for an electric dipole moment in the muon with a sensitivity of 0.1% of a muon Compton wavelength times the electronic charge. The motivation for this investigation is provided by the interest in finding some property of the muon which would indicate a structure different from that of the electron, even though such a structure would violate both parity conservation and time reversal invariance. The muons pass through the fringe field of the cyclotron and an additional system of magnets producing an electric field in their rest frame. Any electric dipole moment would precess about this field producing a vertical plane component of spin transverse to the momentum. This is detected by measuring the electron asymmetry in the plane perpendicular to the momentum. The absence of such a component within the stated sensitivity gives an upper limit to the electric dipole moment of the muon as 2×10^{-18} cm × the charge of the electron.

539.12

9394 THE PROBLEM OF INVESTIGATING THE INTERACTION BETWEEN π-MESONS AND HYPERONS.
L.I.Lapidus and Chzhou Guan-Chzhao [Chou Kuang-Chao].
Zh. eksper. teor. Fiz., Vol. 37, No. 1 (7), 283-8 (July, 1959). In Russian. English translation in Soviet Physics–JETP (New York), Vol. 37 (10), No. 1, 199-202 (Jan., 1960).

It is shown that use of the unitary property of the S-matrix makes it possible to obtain some information about the scattering of π-mesons by Λ- and Σ-hyperons from an analysis of the data on the interaction of K-mesons with nucleons. The possibility of studying the π–Λ and π–Σ interactions by examining peripheral collisions of hyperons with nucleons is discussed.

539.12

9395 MUON CAPTURE IN He^3. A.Fujii.
Phys. Rev., Vol. 118, No. 3, 870 (May 1, 1960).

The hard-core wave-function for a three-nucleon system is used to calculate the capture rate of the reaction $\mu^- + He^3 \to H^3$ (ground state) $+ \nu$. It is found to be 1.66×10^3 sec^{-1}.

539.12

9396 MAGNETIC QUENCHING OF HYPERFINE DEPOLARIZATION OF POSITIVE MUONS.
R.A.Ferrell, Y.C.Lee and M.K.Pal.
Phys. Rev., Vol. 118, No. 1, 317-19 (April 1, 1960).

The depolarization of positive muons being slowed down in an insulating material can only be accounted for by the capture of an electron into a bound state. The ground-state muonium formed in flight can be expected to break up in a time short compared to 10^{-10} sec (the time necessary for the electron to flip the muon spin via the hyperfine interaction). The effect of an external magnetic field in locking the electron spin in its initial orientation, and thereby quenching the action of the hyperfine coupling, is a useful test of the assumption of muonium as the depolarizing mechanism. If x is

the magnetic field strength measured in units of 1.58 kG, and τ is twice the mean life of the muonium atoms with respect to breakup, measured in units of 3.58×10^{-11} sec, then it is found that the amount of depolarization for one formation and breakup process is equal to one-half of the quantity $(1 + \tau^{-2} + x^2)^{-1}$. By introducing n, the number of times that the capture-breakup process is repeated, one has two parameters and can achieve good fits to the experimental data of Sens et al. for nuclear emulsion and fused quartz. It is pointed out that the interpretation by Sens et al. of their magnetic quanching data, also based on a two-parameter formula, is not tenable, since it depends on assuming that a certain fraction of the muons are not subject to the capture and loss process.

539.12

9397 LOW-ENERGY PION PHENOMENA. J.Hamilton and W.S.Woolcock.

Phys. Rev., Vol. 118, No. 1, 291-99 (April 1, 1960).

The relation between low-energy pion–nucleon scattering and pion photoproduction is examined. Correct extrapolation to threshold of both the π^+ and π^- photoproduction data gives agreement with theory. A recent new method for analysing the scattering data is applied giving $a_1 = 0.178$, $a_3 = -0.087$, and reasonable agreement with the Panofsky ratio P = 1.5 is obtained. An inner Coulomb correction to the scattering data helps to improve this agreement. The possibility of detecting a π–π interaction by low-energy pion scattering is examined. A new dispersion relation connects the s- and p-wave phase shifts at low energies; this relation excludes some well-known sets of phase-shift curves.

539.12

9398 T, P, C SYMMETRIES IN THE π^0 DECAY. J.Bernstein and L.Michel.

Phys. Rev., Vol. 118, No. 3, 871-5 (May 1, 1960).

An analysis is given of the decay of π^0 in which allowance is made for possible breakdowns in T, P, and C symmetries. It is shown that experiments, until now, have demonstrated only that the two-photon state is an eigenstate of TP, but not of T and P separately. A discussion of experiments which may verify T and P symmetry for the two-photon state is given.

539.12

9399 OBSERVATIONS OF THE $\pi^0 \rightarrow e^- + e^+ + e^- + e^+$ DECAY Yu.A.Budagov, S.Viktor, V.P.Dzhelepov, P.F.Ermolov and V.I.Moskalev.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1080-4 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 767-71 (Oct., 1959).

An event of charge -exchange scattering, $\pi^- + p \rightarrow \pi^0 + n$, with subsequent decay, $\pi^0 \rightarrow e^- + e^+ + e^- + e^+$, was detected on a photograph taken in a hydrogen diffusion chamber located in a magnetic field and bombarded with 160 MeV π^- mesons. One decay of this type was detected per 2500 π^0-meson decays of the usual $\pi^0 \rightarrow 2\gamma$ type. The π^0-meson mass is estimated as 141 ± 8 MeV. In the rest system of the π^0-meson, the angle between the electrons and positrons of the pairs are 7° and 12°, and the angle between the planes of the pair does not exceed 37°. Other possible explanations of the observed event seem to be very improbable.

539.12

9400 RADIATIVE PION DECAY INTO ELECTRONS. S.A.Bludman and J.A.Young.

Phys. Rev., Vol. 118, No. 2, 602-5 (April 15, 1960).

The possibility of distinguishing the pion structure-dependent radiation from the conventional inner bremsstrahlung radiation in the radiative decay of pions into electrons is discussed. Calculation of the photon energy spectrum and angular correlation shows that evidence for pion structure would be obtained if any photons of energy less than 70 MeV were detected in 180° coincidence with π-decay electrons. The probability of such events per unit solid angle is $> \sim 0.2 \times 10^{-7}$ relative to ordinary $\pi \rightarrow \mu + \nu$ decay, if the assumption of a conserved vector current is made to relate the rate of radiative decay through the weak V-interaction to the rate of $\pi^0 \rightarrow 2\gamma$ decay.

539.12

9401 HIGHER RESONANCES IN PION–NUCLEON INTERACTIONS. R.F.Peierls.

Phys. Rev., Vol. 118, No. 1, 325-35 (April 1, 1960).

The recent experiments on pion–nucleon scattering and photoproduction at energies up to about 1.2BeV are examined from a phenomenological standpoint. The most useful information seems to come from the photoproduction angular distribution and polarization results. The data seem to imply the existence of two "resonances" in the $J = \frac{3}{2}$, odd parity and $J = \frac{1}{2}$, even parity states at photon energies of about 750 and 1100 MeV. These assignments satisfy several nontrivial consistency requirements. The same two states are also a consistent assignment for the observed scattering resonances at 615 and 950 MeV. A qualitative model is proposed to explain these resonances as consequences of the 33 resonance acting in two-meson final states; their isotopic spin dependence seems to require some additional assumptions. Finally, the relation between the photoproduction and scattering phases in the presence of strong inelastic scattering is examined.

539.12

9402 π^+–p INTERACTIONS PRODUCING Σ^+–K^+ IN A PROPANE BUBBLE CHAMBER. W.H.Hannum, H.Courant, E.C.Fowler, H.L.Kraybill, J.Sandweiss and J.Sanford.

Phys. Rev., Vol. 118, No. 2, 577-9 (April 15, 1960).

Seven cases of production of Σ^+–K^+ by 1.0 BeV π^+–p interactions were identified in the Yale propane bubble chamber. In six of these cases, the Σ^+ direction was forward in the centre-of-momentum system. The cross-section derived from these is 0.08 mb. The decay of the Σ^+ is equally divided between the pion and proton decay modes.

539.12

9403 π^-–p INTERACTION 1.4 BeV. V.I.Rus'kin.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 105-8 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 74-6 (Jan., 1960).

The statistical theory of Fermi, taking into account the resonance interaction between a pion and a nucleon, as well as the resonance interaction between two π-mesons, is used to explain the experimental results of the π^-–p interaction at 1.4 BeV. The results obtained are compared with the corresponding results of the "isobaric" model of Sternheimer and Lindenbaum (Abstr. 2493 of 1958).

539.12

9404 POSSIBLE NEW RESONANCE IN THE π^+–p SYSTEM. P.Carruthers.

Phys. Rev. Letters, Vol. 4, No. 6, 303-6 (March 15, 1960).

It is proposed that the π–nucleon scattering data may indicate the existence of a resonance in the T = 3/2, J = 3/2, odd parity state near 900 MeV. Evidence for this is drawn from angular distributions in π^+–p scattering and the absence of appreciable elastic charge exchange scattering of π^- on protons. Possible polarization measurements to check the predictions are discussed. R.F.Peierls

539.12

9405 EFFECTS OF PION–PION INTERACTION IN ELECTROMAGNETIC PROCESSES. L.M.Brown and F.Calogero.

Phys. Rev. Letters, Vol. 4, No. 6, 315-17 (March 15, 1960).

The possible two-pion resonance in the J = 1, I = 1 state would affect the photon propagator. Corrections have been calculated for Møller and Bhabha scattering, and other processes; they might be detectable before long. R.J.N.Phillips

539.12

9406 RELATIVISTIC PION–HYPERON DISPERSION RELATIONS. R.H.Capps and M.Nauenberg.

Phys. Rev., Vol. 118, No. 2, 593-602 (April 15, 1960).

Relativistic, fixed momentum-transfer dispersion relations are derived (but not proved) for pion scattering from Σ and Λ particles and the processes $\pi + \Lambda \rightleftharpoons \pi + \Sigma$. Separate equations for the S- and P-wave amplitudes are obtained under the assumptions that high-energy processes and baryon recoil may be neglected. The P-wave equations are identical to those derived from Chew–Low theory for these processes. A brief discussion is given of the behaviour of the P-wave amplitudes under the assumption of global symmetry. It is pointed out that the production of K–N pairs may play an important role in both the S- and P-wave equations.

539.12

9407 DETERMINATION OF THE COUPLING CONSTANT OF THE π-MESON–NUCLEON INTERACTION FROM THE CROSS-SECTION FOR ELASTIC SCATTERING OF NEUTRONS BY PROTONS AT ENERGY 630 MeV. N.S.Amaglobeli, B.M.Golovin, Yu.M.Kazarinov, S.V.Medved' and I.M.Polev.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 660-2 (Feb., 1960). In Russian.

Experimental data in the angular range $160^0 < \theta < 180^0$ has been improved. Using ten points and extrapolating to the one-pion pole, the value $f^2 = 0.04 \pm 0.005$ was obtained. D.W.L.Sprung

539.12

9408 NUMERICAL EVALUATION OF THE PION–NUCLEON FORWARD SCATTERING AMPLITUDE. J.W.Cronin.
Phys. Rev., Vol. 118, No. 3, 824-7 (May 1, 1960).

The real part of the forward elastic scattering amplitude for $\pi^{\pm}$–proton scattering was evaluated from experimental cross-sections by means of dispersion relations. Recent measurements indicate two peaks in the π^-–proton total cross-section at 590 and 870 MeV incident pion kinetic energy. Tables of the real part of the forward scattering amplitude for $\pi^{\pm}$–proton scattering are presented as a function of incident pion kinetic energy in the laboratory. The forward scattering amplitudes obtained from some recent $\pi^{\pm}$ scattering experiments are compared with the calculations. Measurement of the forward charge-exchange cross-section appears to be the most suitable way of investigating the predictions of the dispersion relation at high energies. The possibility of detecting Coulomb interference at small angles is also discussed.

539.12

9409 PARTIAL WAVE DISPERSION RELATIONS FOR MESON–NUCLEON SCATTERING. R.Oehme.
Phys. Rev. Letters, Vol. 4, No. 5, 246-7 (March 1, 1960).

The analytic properties of the partial wave amplitudes for pion–nucleon scattering are considered. It is shown that a dispersion relation can be written for the partial wave amplitude expressing it in terms of absorptive parts corresponding to the crossed scattering amplitude and to the amplitude for the reaction $\pi + \pi \rightarrow N + \bar{N}$. This enables the pion–nucleon scattering to be connected with the pion–pion scattering. R.F.Peierls

539.12

9410 RESULTS ON THE π^-–PROTON SCATTERING AT 1 BeV AND A COMPARISON WITH THE LINDENBAUM–STERNHEIMER MODEL. I.Derado and N.Schmitz.
Phys. Rev., Vol. 118, No. 1, 309-15 (April 1, 1960).

In photographs from the 10 in. hydrogen bubble chamber at Berkeley, 640 π^-–proton scattering events with two secondary tracks have been analysed. The primary π^- energy was 1 GeV. The cross-sections for the various reactions and especially for the reactions

$$\pi^- + p \rightarrow \pi^- + p,$$
$$\pi^- + p \rightarrow \pi^- + n + \pi^+,$$
$$\pi^- + p \rightarrow \pi^- + p + \pi^0$$

were determined. The ratio $\sigma(\pi^- + p + \pi^0)/\sigma(\pi^- + n + \pi^+)$ of the two inelastic reactions turned out to be $0.50^{+0.19}_{-0.14}$. The differential cross-section of the π^- for the elastic scattering and the momentum and angular distributions of the secondary particles from the two inelastic processes are given The momentum spectra exhibit two maxima which strongly indicate the existence of the isobaric nucleon state. However, these results can hardly be explained quantitatively by the Lindenbaum-Sternheimer model (Abstr. 4776 of 1957; 2493 of 1959), as has been shown in two independent ways. Perhaps this discrepancy is an indication that those pion productions must not be neglected which do not go through the intermediate state of the isobar but through the direct channel.

539.12

9411 POLARIZATION OF RECOIL PROTONS PRODUCED IN ELASTIC SCATTERING AT 307 MeV.
E.L.Grigor'ev and N.A.Mitin.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 413-21 (Aug., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 295-301 (Feb., 1960).

Results are presented of an investigation of the polarization of recoil protons appearing in elastic π^+–p scattering through an angle of 140 ± 8^0 in the c.m.s. at an energy of 307 ± 5 MeV. A polarization value $P_1 = -0.19 \pm 0.17$ has been derived from the data on the magnitude of the left–right asymmetry in elastic scattering of recoil protons on photographic emulsion nuclei. Phase shifts satisfying the indicated polarization value and consistent with the differential cross-section for elastic scattering of π^+-mesons by protons are $\alpha_3 = -23.2^0$; $\alpha_{31} = -8.4^0$; $\alpha_{33} = 133.2^0$; $\delta_{33} = (2^{+9}_{-8})^0$; $\delta_{35} = -(2^{+2}_{-1})^0$. Problems connected with the use of various phase shifts for analysis of the experimental data are discussed.

539.12

9412 [DIFFRACTION] SCATTERING OF FAST PIONS BY DEUTERONS. A.G.Sitenko.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1419-22 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1008-10 (Nov., 1959).

Shadow effects were examined.

539.12

9413 THE POSSIBILITY OF DETERMINING THE AMPLITUDE FOR CHARGE EXCHANGE PION–PION SCATTERING FROM AN ANALYSIS OF THE $\pi^- + p = N + \pi^+ + \pi^-$ REACTIONS NEAR THRESHOLD. A.A.Ansel'm and V.N.Gribov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 501-3 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 354-5 (Feb., 1960).

It is shown that an analysis of experimental data on the energy distribution and angular correlations in the $\pi^- + p \rightarrow n + \pi^+ + \pi^-$, $n + \pi^0 + \pi^0$, and $p + \pi^- + \pi^0$ reactions makes it possible to determine the amplitude for charge-exchange scattering of charged mesons into neutral ones: $\pi^+ + \pi^- \rightarrow 2\pi^0$.

539.12

9414 PION–PION AND PION–KAON SCATTERING. S.Okubo.
Phys. Rev., Vol. 118, No. 1, 357-60 (April 1, 1960).

An easier derivation of Chew–Mandelstam's effective-range formula for pion–pion scattering is given using the conventional Feynman method with the interaction Hamiltonian $H_1 = 4\pi\lambda\phi^4$ in an approximation where only the chain diagrams are included. Furthermore, a correction term to this formula due to the cross-diagram, both for S waves as well as for P waves is calculated. The method has been applied to pion–kaon scattering.

539.12

9415 INVESTIGATION OF ELASTIC SCATTERING OF π^--MESONS WITH 6.8 GeV/c MOMENTUM ON PROTONS IN A PROPANE BUBBLE CHAMBER.
Van Gan-Chan [Wang Kan-Ch'ang], Van Tsu-Tszen [Wang Ts'u-Ts'eng], Din Da-Tsao [Ting Ta-Ts'ao], V.G.Ivanov, Yu.V.Kaĭgshev, E.N.Kladnitskaya, L.A.Kulyukina, Nguyen Dinh Tu, A.V.Nikitin, S.Z.Otvinovskii, M.I.Solov'ev, R.Sosnovskii and M.D.Shafranov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 426-31 (Feb., 1960). In Russian.

The elastic scattering of 6.8 GeV/c momentum negative pions on protons was studied in a propane bubble chamber. The total and differential cross-sections of the elastic scattering were found from 213 events. The total π^- p-interaction cross-section was estimated to be:

$$\sigma_{el}(> 6^0) = 3.75\ ^{+0.25}_{-0.55} \text{ millibarns}, \quad \sigma_{total} = (30 \pm 5) \text{ millibarns},$$

The results of the elastic scattering experiment are consistent with the optical model analysis of the proton as a uniform sphere with sharp boundaries: $R = 1.05 \times 10^{-13}$ cm, $K = 0.71 \times 10^{13}$ cm^{-1}, $k_1 = 0$.

539.12

9416 ELASTIC SCATTERING OF 300 MeV π^--MESONS ON HYDROGEN. I.M.Vasilevskii and V.V.Vishnyakov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 441-4 (Feb., 1960).
In Russian.

Elastic scattering of 300 MeV π^--mesons on hydrogen was studied with the aid of a hodoscope in which the counters were fed by pulsed voltage. On the assumption that elastic scattering is mainly due to S- and P-waves one can represent the angular distribution by

$$d\sigma/d\Omega = [(0.62 \pm 0.06) + (0.30 \pm 0.09)\cos\theta + (0.94 \pm 0.19)\cos^2\theta] \times 10^{-27} \text{ cm}^2/\text{sterad}.$$

539.12

9417 HIGH-ORBITAL S-STATE CAPTURE OF π^- MESONS BY PROTONS. T.B.Day, G.A.Snow and J.Sucher.
Phys. Rev., Vol. 118, No. 3, 864-6 (May 1, 1960).

The consequences of the very short capture time for π^--mesons in liquid hydrogen, recently measure by Fields, Yodh, Derrick, and Fetkovich, are discussed. It is pointed out that collisional de-excitation mechanisms, even including the Stark effect enhancement of capture, seem inadequate to explain the experiment. Alternative possibilities are discussed.

539.12

9418 PION FORM FACTORS FROM POSSIBLE HIGH-ENERGY ELECTRON–POSITRON EXPERIMENTS.

N.Cabibbo and R.Gatto.

Phys. Rev. Letters, Vol. 4, No. 6, 313-14 (March 15, 1960).

Discusses pion production from high-energy electron–positron annihilation, and the light such reactions may throw on the theory of σ–n^{π} vertices. R.J.N.Phillips

539.12

9419 PION PRODUCTION AND THE PION-PION INTERACTION. L.S.Rodberg.

Phys. Rev. Letters, Vol. 3, No. 1, 58-9 (July 1, 1959).

The static-model pion–nucleon interaction fails to account for the high cross-section observed experimentally of the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ in the energy range from 260 to 430 MeV of incident pion energy. An attempt is made to fit the results by a theory using a pion–pion interaction, with S-wave interaction predominating at low energies and an increasing contribution of P-wave interaction at higher energies. By a suitable choice of parameters for the S and P wave phase-shifts agreement with the experimental data is obtained. These suggest a rapid change of the S/P ratio in the energy range covered. This should manifest itself by angle-energy correlations. Choice of isospin 1 in the P-wave interaction leads to predictions for the charged to neutral pion production ratio at incident pion energies exceeding 400 MeV. E.G.Michaelis

539.12

9420 PHOTOPRODUCTION OF NEUTRAL π-MESONS ON HYDROGEN BY GAMMA QUANTA WITH ENERGY BETWEEN THE THRESHOLD AND 240 MeV.

R.G.Vasil'kov, B.B.Govorkov and V.I.Gol'danskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 11-22 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 7-14 (Jan., 1960).

The angular distribution of the π^0-mesons was investigated. The energy dependence of photoproduction was studied, employing the method of a multichannel analysis of the data of the monitor and of the counters recording single decay γ quanta during an expanded synchrotron pulse. The angular distribution of the π^0-mesons in the c.m.s has the form

$$d\sigma/d\Omega = A + B\cos\theta + C\cos^2\theta,$$

where A, B and C are determined by the contribution of the different variants (E1, M1, E2) of the absorption γ-quanta. This signifies that the photoproduction of π^0-mesons occurs not only in the P but also in the S state. The experimental data on the contribution of the S state are in agreement with the results of the calculations based on Watson's (Abstr. 2450 of 1956) and Feld's (Abstr. 7257 of 1958) theories and makes it possible to estimate the contribution of the direct π^0-meson photoproduction processes and the "intranucleon charge exchange" of π^+-mesons in the S state.

539.12

9421 PHOTOPRODUCTION OF LOW-ENERGY CHARGED PIONS FROM COMPLEX NUCLEI.

V.M.Popova, N.G.Semashko and F.R.Yagudina.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1357-9 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 965-6 (Nov., 1959).

The yields of charged photomesons with energies from 0 to 3 MeV at an angle of 90° to a photon beam were investigated for Be, C, Al and Cu nuclei. The maximum photon energy was 265 MeV. The dependence on the negative π-meson yield and the ratio of the positive versus negative π yield on the atomic number were found. Comparison of the experimental data with the physical calculations of Baldin and Lebedev (Abstr. 6166 of 1958) gave the result that the mesons are formed from the nucleons on the nuclear surface.

539.12

9422 INVERSE DISPERSION RELATIONS FOR PHOTOPRODUCTION OF π-MESONS ON NUCLEONS.

N.F.Nelipa and V.A.Tsarev.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 259-60 (Jan., 1960). In Russian.

The imaginary part of the amplitude for the process is expressed as an integral over the real part. It is hoped that this form of dispersion relation will be more suitable than the direct one at high energies. P.K.Kabir

539.12

9423 DISPERSION-RELATIONS ANALYSIS OF THE π-MESON PHOTOPRODUCTION DATA IN THE THRESHOLD REGION. A.M.Baldin.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 579 87 (Feb., 1960). In Russian.

It is found that in the near threshold region data on photoproduction of π-mesons can be directly compared with the dispersion relations. This new method of analysis is applied to available experimental data on photoproduction of π^0- π^+- and π^--mesons. The cause of the serious discrepancy between the predictions of the dispersion relations and the experimental data found by McDonald et al. (Abstr. 8892 of 1957) is investigated. Experiments are suggested which should ascertain whether this disrepancy is the result of a large contribution of high-energy regions to the dispersion integrals. The solution of this problem should be of great importance in development of a pion photoproduction theory based on the dispersion relations.

539.12

9424 COMPARISON OF THE PHOTOPRODUCTION OF A π^0-MESON ON A PROTON WITH THE PREDICTION OF THE DISPERSION THEORY.

K.Dietz, G.Höhler and A.Müllensiefen.

Z. Phys., Vol. 159, No. 1, 77-88 (1960). In German.

The real parts of the photoamplitudes E1 $S_{1/2}$, M1 $P_{1/2}$, M1 $P_{3/2}$ have been calculated from the angular distribution of the reaction $\gamma + p \rightarrow p + \pi^0$, recently measured by Goldansky et al. at 160 to 240 MeV (Abstr. 12584 of 1959). One of the solutions fits fairly well to the theoretical prediction for the M1 $P_{3/2}$ amplitude according to the dispersion method of Chew, Goldberger, Low and Nambu (1957). There is a discrepancy for M1 $P_{1/2}$ if α_{11} is taken from the effective range formula, but the positive values of α_{11}, necessary to give agreement, are not excluded by the results of the phase shift analysis, especially since Pontecorvo et al. (1959) have recently found positive values at higher energies. The prediction for the real part of the E1 $S_{1/2}$ amplitude agrees with the experimental data, if pretty large recoil corrections are added which had been neglected by Chew et al.

539.12 : 539.17

π-MESON PRODUCTION IN THE INTERACTION BETWEEN 9 BeV PROTONS AND EMULSION NUCLEI. See Abstr. 9619

539.12 : 539.14

9425 PRODUCTION OF π-MESONS IN pd-COLLISIONS AND INTERNAL NUCLEAR MOTION OF NUCLEONS.

Yu.D.Prokoshkin.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 455-61 (Feb., 1960). In Russian.

It is shown that the energy dependence of the cross-sections for production of π-mesons in nucleon–deuteron collisions and the energy spectra of π-mesons can be calculated with a rather good accuracy on basis of data on free nucleon–nucleon collisions. In the energy range from the threshold of meson production to ~ 700 MeV the influence of the nucleon binding in deuterons mainly leads to a change in the magnitude of the cross-sections as a result of internal nuclear motion of the nucleons. The effective momentum distribution of nucleons in the deuteron was found.

539.12

9426 PION PRODUCTION BY PIONS.

W.A.Perkins, J.C.Caris, R.W.Kenney, E.A.Knapp and V.Perez-Mendez.

Phys. Rev. Letters, Vol. 3, No. 1, 56-7 (July 1, 1959).

The reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ has been studied at π^- energies of 260, 317, 371 and 427 MeV by means of a liquid hydrogen target. Since the incident pion energy is insufficient for pion pair production the presence of the π^+, identified by its decay, characterizes the interaction. The positive pion flux was measured at centre of mass angles of 60°, 90°, 125° and 160°. By integration over energy and angle the total cross-section was obtained as a function of the incident energy. This cross-section exceeds systematically the predictions of the static model obtained by Rodberg and Kazes (1957) which assumes only a direct pion–nucleon interaction. This is taken as evidence in favour of the direct interaction between the π^- and the π^+ in the meson cloud surrounding the nucleon. E.G.Michaelis

539.12

9427 AN UNUSUAL DOUBLE STAR FROM A K^--CAPTURE IN EMULSION.

M.Nikolič, W.Koch, M.Schneeberger and H.Winzeler.
Nuclear Phys., Vol. 15, No. 3, 519-21 (March (1), 1960).

The event is interpreted as either a radiative Σ^--decay, or a Σ^--compound, or a Λ^0 hyperfragment heavier than any so far reported. E.J.Burge

539.12

9428 CHARGE DISTRIBUTION OF PIONS PRODUCED IN HIGH ENERGY NUCLEAR COLLISIONS. Y.Yamamoto.
Progr. theor. Phys., Vol. 15, No. 181-6 (July, 1957).

The charge distribution of pions produced in a high energy collision of two nucleons is calculated by means of a statistical model including excited nucleons. The results are compared with experimental data. The qualitative agreement is obtained for the ratio of (single π^-) to ($\pi^- + \pi^0$) to ($\pi^+ + \pi^-$) in an n–p collision, but not for the ratio of (π^+) to (π^-) in a p–Be collision.

539.12

9429 DISPERSION RELATIONS FOR INELASTIC PROCESSES INVOLVING K-MESONS. Yu.Vol'f.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1379-84 (Nov., 1959).
In Russian.

Dispersion relations for processes of the $K + N \rightarrow Y + \pi$ type are presented. The intermediate state spectrum is investigated. The structure of the amplitude for scalar and pseudo-scalar K-mesons is given.

539.12

9430 THE ULTRAVIOLET ASYMPTOTIC VALUE FOR THE INTERACTION OF K-MESONS WITH BARYONS.
G.Wrzecionko.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 908-104 (July, 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 69-73 (Jan., 1960).

Studied for different kinds of relative baryon parity under the assumption of weak coupling.

539.12

9431 INTERACTION OF K^+ MESONS WITH PROTONS. T.F.Kycia, L.T.Kerth and R.G.Baender.
Phys. Rev., Vol. 118, No. 2, 553-61 (April 15, 1960).

The total K^+–p cross section was measured at the three K^+-meson energies 175 ± 25, 225 ± 25, and 275 ± 25 MeV, and the differential scattering cross-section was measured at 225 MeV. The K^+–p nuclear force was shown to be repulsive, from the observed constructive interference with Coulomb scattering. The differential cross-section was otherwise isotropic and could arise from either pure S-wave or pure P-wave scattering. Subtracted dispersion relations were applied to these data and the rest of the available K–proton scattering data. The statistical errors in the data were found to be too large to determine the K–hyperon relative parity. On the assumption that the $K\Lambda$ and $K\Sigma$ relative parities are the same, then for scalar coupling, $g^2/4\pi$ would be less than 0.6; for pseudo-scalar coupling, it would be less than 10.

539.12

9432 K^- ABSORPTION AND $\pi-\Sigma$ PHASE SHIFTS. R.H.Capps.
Phys. Rev., Vol. 118, No. 4, 1097-9 (May 15, 1960).

The relations between $\bar{K} + N \rightarrow \pi + Y$ absorption amplitudes and pion–hyperon scattering amplitudes that are implied by the unitarity of the scattering matrix are considered. It has been shown by Kawarabayashi that if Λ production and the K^0–K^- mass difference are neglected, the zero kinetic energy K–p absorption data of the Berkeley hydrogen bubble chamber group imply that at least one of the angular momentum $\frac{1}{2}$ pion–hyperon scattering amplitudes is much larger than are any of the $j = \frac{1}{2}$ pion–nucleon amplitudes at a corresponding energy. It is demonstrated that the conclusion of Kawarabayashi remains valid if one includes the effects of Λ production and the K^0–K^- mass difference.

539.12

9433 CHARGE-EXCHANGE CROSS SECTION OF 175-TO 250-MeV K^+ IN CARBON, COPPER, TUNGSTEN, AND NUCLEAR EMULSION.
M.N.Whitehead, R.E.Lanou, Jr, V.Cook, Jr and R.W.Birge.
Phys. Rev., Vol. 118, No. 1, 300-8 (April 1, 1960).

The disappearance and presumed charge exchange of K^+ mesons has previously been observed in nuclear emulsions. The authors measured the charge-exchange cross-section for K^+ energies between 150 and 250 MeV in C, Cu, W, and, as a check, in nuclear emulsion. In addition, a scintillation-counter array was used to detect the charged decay mode of the short-lived K_1^0 produced in the charge-exchange reaction. The measured mean free path in nuclear emulsion is 195 ±25 cm at 200 MeV. The average corrected free-nuetron cross-section deduced from the pure elements is 5.9 ± 0.4 mb. From K^+ charge exchange, and assuming a branching ratio of $\frac{1}{3}$ for decay into the $2\pi^0$ mode compared to all decays for the K_1^0 state, a K_1^0/K_2^0 ratio consistent with unity is found.

539.12

9434 HIGH-ENERGY K$^-$-MESON INTERACTIONS AND DECAYS. S.C.Freden, F.C.Gilbert and R.S.White.
Phys. Rev., Vol. 118, No. 2, 564-76 (April 15, 1960).

The interactions of 20 to 300 MeV K^--mesons on free protons and on emulsion nuclei were studied and their decays analysed. The K^--meson mean lifetime is found to be $(1.38 \pm 0.24) \times 10^{-8}$. Examples of the decay modes $K_{\mu 2}$, $K_{\pi 3}$, $K_{\mu 3}$, τ, and τ' are identified. The branching ratios are found to be in agreement with those for K^+-mesons. The (K^-p,K^-p) elastic scattering cross-section is found to be 35 ± 16 mb and the (K p, $\Sigma^{\pm}\pi^{\mp}$) cross-section 27 ± 13 mb in the energy region of 150 to 300 MeV. The mean free path for K^--meson captures and inelastic scatters on emulsion nuclei, except hydrogen, can be represented by $\Lambda(\text{cm}) = (17.2 \pm 3.4) + (0.081 \pm 0.027)T_K$, where T_K is the laboratory K^--meson kinetic energy, for K^--meson energies from 20 to 300 MeV. This increase in the mean free path with K^--meson energy is explained in terms of the decreasing nucleon cross-section. The fraction of the interactions of K^--mesons on nuclei which are inelastic scatters increases from 2% at low K^--meson energies to about 15% at 150 MeV. This increase in inelastic scattering with energy is additional evidence that the nucleus is becoming partially transparent to K^--mesons at about 150 MeV. Data are presented for the fraction of events with observed π-mesons, Σ-hyperons, and π-meson–Σ hyperon pairs. The data are discussed in terms of the model which was previously presented to explain K^--meson captures at rest on nucleons bound in nuclei.

539.12

9435 INTERFERENCE PHENOMENA IN NUCLEAR SCATTERING OF NEUTRAL K MESONS. N.N.Biswas.
Phys. Rev., Vol. 118, No. 3, 866-9 (May 1, 1960).

The scattering of neutral K mesons is treated phenomenologically. The scattered beam, in general contains both K_0 and $\bar{K}_0$ components having different amplitudes. These amplitudes interfere with each other in the generation of K_1 and K_2 components in the scattered beam. The relative sign of the two amplitudes may then be determined from the analysis of K_1, K_2 decays. The leptonic decay rates of the scattered beam show a dependence on Δ M, the mass difference between K_1, K_2 in such a way that the sign of Δ M can, in principle, be determined experimentally.

539.12 : 539.14

K^+–He^4 ELASTIC SCATTERING : APPROXIMATE EVALUATION.
See Abstr. 7447

Hyperons

539.12

9436 ON THE OBSERVABILITY OF A NEW HYPERON. S.H.Hsieh.
Progr. theor. Phys., Vol. 18, No. 2, 211-12 (Aug., 1957).

The Landau–Belenkii multiple production theory is used in an attempt to determine the existence and observability of a new meson. It is claimed that the method of analysis used is valuable for the investigation of various phenomena of cosmic rays and new particles. C.F.Barnaby

539.12

9437 PARITY NONCONSERVATION AND DECAY OF HYPERON. S.Minami and Y.Yamaguchi.
Progr. theor. Phys., Vol. 18, No. 1, 39-50 (July, 1957).

Under the assumption that the parity conservation does not hold for the decay processes of strange particles, the angular distribution of the final decay product for the cascade decay of the Ξ hyperon was

examined and also the asymmetrical distribution of the decay product about the production plane of hyperons which are produced by a K^-–p interaction. So far as the kinematical study for these processes is concerned, it is possible to know whether the decay interaction is invariant under the time reversal. However, there exists a possibility of solving this problem by using values of phase shifts for π–N scattering. Namely, if the two decay interactions, $\Xi \rightarrow \Lambda + \pi$ and $\Lambda \rightarrow N + \pi$, are invariant under the time reversal, it may be expected that the fore-aft asymmetry (with respect to the direction of motion of Λ) of the final decay product for the cascade decay will be observed, while if they are simultaneously invariant under the charge conjugation, the existence of asymmetrical angular distribution probably cannot be confirmed.

539.12

9438 INTERFERENCE OF FORM-FACTORS IN LEPTONIC DECAY OF HYPERONS. V.M.Shekhter.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 534-40 (Feb., 1960). In Russian.

It is possible to deduce the energy dependence of the coefficients before the products of various form-factors in the expression for the probability of leptonic decay of hyperons and also to predict when some of these coefficients vanish by making use of invariance of the four-fermion-interaction matrix element under some formal transformations, no direct calculations being required for this purpose. See also following abstract.

539.12

9439 A POSSIBILITY OF DETERMINATION OF FORM-FACTORS IN LEPTONIC DECAY OF HYPERONS. V.P.Belov, B.S.Mingalev and V.M.Shekhter.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 541-52 (Feb., 1960). In Russian.

The energy correlation and asymmetry of emission of particles produced in leptonic decay of hyperons and also the polarization of the emitted nucleons or secondary hyperons were calculated allowing for all six form-factors of the decay V–A-interaction. A method of comparison of the theoretical formulae with the experimental data is suggested which permits one in principle to determine the form-factors. A similar calculation is presented in the appendix when all five types of decay interaction are retained and the form-factors are neglected. See preceding abstract.

539.12 : 539.14

9440 SPIN AND SIZE OF Λ^0 PARTICLE. K.Nishimura.

Progr. theor. Phys., Vol. 18, No. 6, 665-6 (Dec., 1957).

Discusses the effect of Λ^0 size on the ratio of mesonic to non-mesonic decay of ${}_{\Lambda}He^4$ hyperfragments, and hence on deductions about the Λ^0 spin. R.J.N.Phillips

539.12

9441 ELEMENTARY PARTICLE REACTIONS. II. H.C.Meyer, III and W.G.Holladay.

Nuovo Cimento Suppl., Vol. 15, No. 3, 387-401 (1960).

An extension of previous work (Abstr. 4210 of 1958). Presents tables of the two, three and four particle final states that can come from a hyperon or anti-hyperon incident on a nucleon, with threshold energies. Also discusses thresholds for multi-stage processes. R.J.N.Phillips

Strange particles

539.12

9442 CROSS-SECTION FOR THE PRODUCTION OF Ω^--PARTICLES IN THE REACTIONS $\pi^- + p \rightarrow \Omega^- + 3K$ AT 8 GeV AND $p + \bar{p} \rightarrow \Omega + \bar{\Omega}$ AT 4 GeV. Syan' Din-Chan [Hsien Ting-Ch'ang].

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 289-90 (Jan., 1960). In Russian.

Using the Fermi statistical theory as modified by Barashenkov (Abstr. 5193 of 1958), the production cross-sections are calculated for a hypothetical hyperon with strangeness -3 and mass intermediate between 1.58 and 1.93 nucleon masses. P.K.Kabir

Deuterons

539.12

9443 THEORY OF THE PHOTODISINTEGRATION OF THE DEUTERON. L.D.Pearlstein and A.Klein.

Phys. Rev., Vol. 118, No. 1, 193-211 (April 1, 1960).

By means of a covariant field-theoretic technique, a formally exact expression has been derived for the amplitude for photodisintegration of the deuteron. By expanding the result only in the number of mesons exchanged and by making a series of nonrelativistic approximations, the expression is reduced to one in which the corrections to the conventional dipole matrix element depend only on the amplitude for photomeson production, the renormalized meson–nucleon coupling constant, and the appropriate two nucleon wave-functions. One finds that virtual meson effects play little role at energies below 100 MeV, in justification of recent calculations based on the conventional nonrelativistic theory. At higher energies good agreement with the total cross-section was obtained by the inclusion of both hard core and tensor force effects in the wave-functions. In addition the folded angular distribution could be fitted by using a reasonable extrapolation of the phase shifts in the ${}^1S_0$ and ${}^1D_2$ states.

539.12

9444 PHOTODISINTEGRATION OF THE DEUTERON NEAR 11 MeV. S.-H.Hsieh.

Progr. theor. Phys., Vol. 18, No. 6, 637-48 (Dec., 1957).

It is shown that the photodisintegration is consistent with nucleon–nucleon scattering at the corresponding energy. Some features of the nuclear forces are elucidated in this analysis. It is shown that the phase shift of the singlet even state is somewhat smaller than that previously supposed, and the phase shifts of the triplet odd state are not small at 11 MeV.

Tritons

539.12 : 537.54

340 kV ACCELERATOR FOR THE STUDY OF REACTIONS INDUCED BY TRITONS. See Abstr. 9113

Alpha-particles

539.12

9445 ELECTRODISINTEGRATION OF He^4 NUCLEUS. T.Muto and T.Sebe.

Progr. theor. Phys., Vol. 18, No. 6, 621-36 (Dec., 1957).

The inelastic continuum of electrons scattered by He^4 nuclei, observed experimentally by the Stanford group, is worked out theoretically by using the conventional forms of wave-functions for He^4, He^3 and triton, respectively. It is shown that two kinds of scattering are involved in the cross-section; one is connected with the direct process in which a nucleon can be ejected through the direct interaction with the electromagnetic field induced by the electron and the other one, with the indirect process in which a nucleon is capable of being ejected through the intermediary of nuclear interaction with another nucleon which does interact with the electromagnetic field. The comparison of the results with experiments appears to be qualitively good, allowing for the approximate nature of the method of computation. The main nuclear reaction connected with the observed inelastic continuum is shown to be the ejection of a nucleon from He^4 except for the low-energy tail where the pion production is observed to take place according to the Stanford group.

539.12

9446 RANGES OF 4.5 MeV α-PARTICLES IN URANIUM, GOLD, ZIRCONIUM AND SILICON. A.Garin and H.Faraggi.

J. Phys. Radium, Vol. 19, No. 1, 76-8 (Jan., 1958). In French.

The ranges in different elements was measured using U alloys of known concentration in U and the following values obtained: Si–5.2 ± 0.1 mg/cm^2; Zr–11 ± 0.35 mg/cm^2; Au–17 ± 0.6 mg/cm^2; U–19.2 ± 0.4 mg/cm^2. Comparison is made with previous results and it is shown that within the limit of experimental error the additivity rule and the Bragg–Kleeman rule are verified.

539.12

9447 THE SCATTERING OF ALPHA PARTICLES BY HELIUM. D.J.Bredin, W.E.Burcham, D.Evans, W.M.Gibson, J.S.C.McKee, D.J.Prowse, J.Rotblat and J.N.Snyder. Proc. Roy. Soc. A, Vol. 251, 143-55 (May 26, 1959).

In order to obtain information about the levels of even spin and parity of Be^8 at energies above 11 MeV, the differential cross-section for α-particle–helium elastic scattering was measured at a series of beam energies from 23.1 to 38.4 MeV, for many c.m.s. angles between 30 and 90°. Phase shifts up to L = 8 were calculated for each energy. Combining these results with previous figures for lower energies, the phase-shifts δ_2, δ_3 and δ_4 are thus known as functions of incident energy from 0.15 to 38.4 MeV. The behaviour of the phase shift δ_4 confirms the existence of a previously suggested level with I = 4 at an excitation energy of about 11.4 MeV in Be^8. The phase shifts δ_6 and δ_8 are small, as expected if the rotational series of levels in Be^8 terminates with I = 4.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

537.59

9448 MULTIPLE MESON PRODUCTION IN NUCLEON-NUCLEON INTERACTIONS AT ENERGIES OF 10^{13} eV. M.Schein, D.M.Haskin, E.Lohrmann and M.W.Teucher.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 6-25.

A nuclear interaction of type 0 + 20p observed in nuclear emulsion was analysed by measuring the energies and angles of the secondary particles. The primary energy, as determined from the angular distribution of the tracks, is 2.7×10^{13} eV. This value is in agreement with an independent estimate obtained from the total energy dissipated. A secondary collision of type 0 + 20n was also analysed in the same way. Its energy is 1.4×10^{13} eV, which is comparable to the primary energy. The inelasticity of the primary event if $0.54^{+.18}_{-.10}$. Energy and angular distributions of the shower particles in the centre of mass system (CMS) are given for both events. The shower particles show a correlation in the sense that those with the highest energies are emitted in the CMS under small angles with the shower axis. The energy distribution of the mesons in the CMS is peaked toward low energies and shows a remarkably long tail at high energies extending up to 10 BeV. One of these particles is a π^0-meson, which carries off about 23% of the total energy. The average value of the transverse momentum of the shower particles is 0.3 ± 0.05 BeV/c. 54 references are given.

537.59

9449 ANALYSIS OF ANGULAR DISTRIBUTION OF THIN TRACKS OF SHOWERS PRODUCED BY PARTICLES WITH ENERGIES > 10^{11} eV. Zh.S.Takibayev, A.A.Loctionov, L.A.San'ko and Ts.I.Shakhova.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 56-66.

Angular distribution of thin tracks of showers produced by cosmic particles with energies ≥ 10^{11} eV in the stratosphere is investigated. The characteristics of showers in the energy ranges of 10^{11} eV < E ≤ 10^{12} eV and E > 10^{12} eV are compared with various theoretical representations To explain a number of peculiarities of the angular distribution (for instance, the presence of double-peaked distribution in certain showers) it is recommended that one takes into account the role of the particles produced (antinucleons, pions) in the formation of an additional number of particles in secondary collisions within the target nucleus. The angular distribution of shower particles produced by multi-charge particles is also analysed. A case of 15 + 515 Z produced by a silicon nucleus with an energy of about 600 BeV per nucleon is described.

537.59

9450 INVESTIGATION OF ENERGY SPECTRUM OF PARTICLES PRODUCED IN HIGH-ENERGY NUCLEAR INTERACTIONS. A.Kh.Vinitsky, I.G.Golyak, Zh.S.Takibayev and I.Ya.Chasnikov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 67-76.

Discusses showers in which the authors succeeded in determining the energy of the produced particles by measuring multiple Coulomb scattering or, in rare cases, by measuring the relative scattering of adjacent particles. In the case of two showers (2 + 16p. and 2 + 14n) the spectrum of γ-quanta resulting from the decay of π^0-mesons was obtained, the γ-quanta energy being determined on the basis of the analysis of the electron-positron pairs produced by them. The experimental data thus obtained are compared with the spectrum of γ-quanta resulting from different versions of the theory of multiple meson production.

537.59

9451 ESTIMATION OF THE ENERGY (E > 5 × 10^{10} eV) OF PRIMARY PARTICLES BY THE ANGULAR AND ENERGY DISTRIBUTION OF SECONDARY SHOWER PARTICLES. E.G.Boos and J.S.Takibayev.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 82-94.

By means of a method based on the use of the transverse momentum of shower particles an estimation is made of the Lorentz factor γ_c, the mean energy $\bar{\epsilon}'$ of the generated particles and the part of the energy K transferred to these particles in the centre of mass system (C.M.S.). The correlation between the values K, $\bar{\epsilon}'$, n_s and γ_c is studied within the frame-work of this method. In assessing the value of γ the energy spectrum of the shower-generating component is taken into account. It is shown that in all theories and models discussed in the paper, referring to multiple meson generation in which the primary nucleons are not separated from the emitting centres, the nature of the dependence between K and γ_c does not correspond to that observed in experiment.

537.59

9452 NUCLEON–NUCLEON COLLISIONS OF ENERGIES BETWEEN 10 AND 100 GeV. S.Kaneko, O.Kusumoto, S.Matsumoto and M.Takahata.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 107-12.

Nine nuclear interactions of primary energies between 10 and 300 GeV, which could be explained in terms of nucleon–nucleon collisions, have been analysed. The energy and angular distributions of the secondary particles in the centre-of-mass system have been obtained. The energy spectrum of inverse square type agrees well with experiment except for the low energy end. The angular distribution seems to be essentially isotropic.

537.59

9453 CONSEQUENCES OF THE TWO-CENTRES MODEL OF PARTICLE EMISSION IN COSMIC RAY JETS. J.Pernegr.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 121-6.

It has been shown recently by the Polish-Czech group (Abstr. 3930 of 1959), Cocconi (Abstr. 3738 of 1959) and Niu (Abstr. 3754 of 1959) that the angular distribution of secondaries in high energy cosmic ray jets might be described on the basis of a simple "two-centre model" of particle emission. Several possibilities are discussed of obtaining independent proofs of the validity of this model.

537.59

9454 STUDIES OF THE NATURE AND SPECTRA OF PARTICLES GENERATED BY HIGH-ENERGY NUCLEONS. A.I.Alikhanov, A.V.Khrimyan, V.K.Kosmachevsky, V.V.Avakyan, Yu.V.Gorodkov, K.Sh.Egiyan, and N.A.Nalbandyan.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 182-7.

The present paper reports the results of investigations into the nature and spectra of particles with momenta up to 900 MeV/c generated in lead under the action of high-energy cosmic-radiation nucleons at 3200 metres above sea level (Mt. Aragats, Armenia). The instrument used consists of a mass spectrometer (magnetic field intensity 6850 Oe), a supplementary hodoscope device positioned over the spectrometer, a 5-layer thin-walled proportional counter and five scintillation counters. The apparatus permits observation of nuclear disintegrations caused by fast nucleons in lead generators 25 cm thick situated in compartments of the hodoscope device, and determination of the momenta of the secondary particles, their ionizing capacities and the character of passage through the lead and copper filters under the spectrometer. The root-mean-square error in the determination of 0.2 BeV/c and 1 BeV/c momenta comes out to 8:5% for protons and 2:4% for pi-mesons, respectively. The ionizing

capacity of the individual particles was determined with an average accuracy of ± 14% by means of a gas counter and of ± 10% by means of five scintillation counters.

537.59

9455 INTERPRETATION OF COSMIC RAY JETS AS COMPOSITE COLLISIONS: THE TWO-CENTERS MODEL. K.Sitte and L.Katz.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 249-53.

Arguments previously reported in support of a composite-collision picture of cosmic ray jets have been extended to describe the events in the language of the two-centres model. From general kinematic considerations, expressions are derived to calculate the number of participating nucleons as well as their energies before and after the collision. In suitable cases, these results can also be checked by a purely phenomenological analysis of the forward and backward cones. Results from a number of jets observed by the Polish–Czech emulsion group demonstrate the general tendency in jets of large n_s and large N_h of dividing unequally into forward and backward cones, with the backward particles outnumbering the others by a factor of about 2. Finally, it is pointed out that in high-energy jets a third, smaller centre may occur, formed by energetic secondaries emitted at an early stage of the expansion of the meson cloud before its separation into two individually emitting systems.

537.59

9456 EXCITED NUCLEON INTERPRETATION OF HIGH ENERGY NUCLEAR INTERACTIONS. E.J.M.Farley.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 254-70.

An analysis of the kinematics of the excited nucleon model leads to three relationships which are found to be in fair agreement with the experimental data: (i) inelasticity–n_s relation; (ii) backward angle–n_s relation; and (iii) forward angle–primary energy relation. A simple statistical treatment of the excited nucleon itself gives a good fit to the transverse momentum distribution in the jets.

537.59

9457 μ-MESON SPECTRUM AT A DEPTH OF ~ 40 m WATER EQUIVALENT. MEASUREMENT OF THE MASS OF COSMIC RADIATION PARTICLES BELOW THE SURFACE OF THE EARTH. M.I.Dayon [Daion] and L.I.Potapov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 301.

Brief note, substantially as follows: The magnetic spectrometer method was used to obtain a momentum spectrum of μ-mesons at a depth of approximately ~ 40 m.w.e. in the momentum range of $2 \times 10^9 \sim 5 \times 10^{10}$ eV/sec. This spectrum is compared with the Caro spectrum and other spectra measured at sea level. The mass value for 370 particles stopped in the filter (interval of ranges: 4 cm Pb < R < 16 cm Pb) determined by momentum and range. The values obtained agree with the value of the mass of the μ-meson (π- and μ-mesons are not resolved by the instruments. For complete text see Abstr. 12435-6 of 1959. A discussion of some results of the work is given in the paper of Ashton, Wolfendale and Nash. (See following abstract.

537.59

9458 THE MOMENTUM SPECTRUM OF COSMIC RAYS UNDERGROUND AT A DEPTH OF 38 m. WATER EQUIVALENT. F.Ashton, A.W.Wolfendale and W.F.Nash.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 302-3.

The cosmic ray spectrum was determined at a depth of 38 m.w.e. using a magnetic spectrograph of maximum detectable momentum 8 GeV/c. By comparing this spectrum with the ground level spectrum the energy loss of fast μ-mesons in penetrating the overlying rock has been determined. It is shown that the rate of energy loss is as expected by theory. In consequence underground spectra predicted by extrapolation of the ground level spectrum are expected to be accurate, at least for moderate depths.

537.59

9459 ON SOME PROPERTIES OF EXTENSIVE AIR SHOWERS OBTAINED BY CONTINUOUS RECORDING OF SHOWER FREQUENCY NEAR SEA LEVEL. D.D.Krasilnikov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 188-91

In 1957-1958, an array of 360 Geiger–Müller counters was assembled and installed at Yakust (100 m above sea level) to record time variations of the frequency of extensive air showers (EAS) having various average numbers of particles. The experimental equipment and some initial results obtained from analysis of the observed data are described.

537.59

9460 AN ANALYSIS OF EXPERIMENTAL DATA ON EXTENSIVE AIR SHOWERS. S.Miyake.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 209.

Brief note, substantially as follows: The main interest of the present paper is in analysing the fluctuations in the starting points of extensive air showers in the atmosphere. A method of obtaining the shower curve without taking into account the effect of the fluctuations is presented. The latter effect results in that small energy showers which thrust themselves into the lower atmosphere are observed as if they were large energy showers, and the effect is not insignificant especially in the case of observing showers of large sizes at low altitudes. This may also modify the primary energy spectrum in such a way that the intensity at very high energies is significantly smaller than the one currently adopted. Qualitative interpretations of some unusual events and some speculations on high energy nuclear interactions are also given. For complete text see Progress of Theoretical Physics, Vol. 20, No. 6, Dec., 1958, pp. 844-56.

537.59

9461 COMPARISON OF THE ELECTRON NUMBER DISTRIBUTION IN ELECTRON–PHOTON SHOWERS IN AIR AND ALUMINIUM ABSORBERS. J.C.Butcher and H.Messel.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 243-55.

Numerical results for the number distribution of electrons above a given energy due to primary electrons and photons are compared for air and aluminium absorbers. Comparisons are made for a number of typical cases: electron and photon primaries of energy 500, 2000 and 10 000 MeV and secondary electron energies of 5, 20 and 100 MeV respectively. Graphs are given for the six comparable cases for the average numbers and six comparable cases for the probability of finding more than 3 electrons at a given depth of absorber. Twelve sets of comparable curves are also given for the probability of finding individual numbers of electrons. The more accurate Bethe–Heitler cross-sections at low energies are used and collision losses and Compton effect are taken into account but scattering at low energies is neglected. The results were obtained using Monte Carlo methods on the electronic digital computer SILLIAC.

537.59

9462 INVESTIGATION OF A HIGH ENERGY ELECTRON-PHOTON CASCADE IN EMULSION. E.Fenyves, A.Frenkel, F.Telbisz, J.Pernegr, V.Petrzílka, J.Sedlák and J.Vrána.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 290-3.

A photon initiated high energy electron–photon cascade was investigated. The energy of the primary photon was determined from the longitudinal development and the lateral distribution of the cascade to be about 2×10^{12} eV. The energy spectrum of electron pairs generated on the first 1.5 cascade units was measured. The spectrum obtained does not deviate significantly from either the spectrum calculated by the Bethe–Heitler (1954) theory or from that calculated by Migdal (Abstr. 462 of 1957) extending the Landau–Pomerančuk–Ter-Mikaelyan theory (1953-54).

537.59

9463 ON COUPLING COEFFICIENTS BETWEEN THE PRIMARY AND SECONDARY VARIATIONS OF COSMIC RADIATION IN THE HIGH-ENERGY RANGE. L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 47.

Brief note, substantially as follows. Coupling coefficients are calculated in the region of high energies on the basis of definite conceptions concerning the elementary interaction event of primary particles with nuclei of the air. The integral multiplicity, i.e. the number of secondary particles recorded by an instrument from a single primary particle of different energy, is found. Underlying the calculation is the following elementary event: after interaction, the primary particle carries off 50% of the energy, the δ-nucleon carries off 10%, and the remaining 40% is accounted for by charged

and neutral π-mesons. Taken into account is the decay and capture of π-mesons with subsequent formation of μ-mesons and the probability of the μ-mesons reaching the level of registration (allowing for ionization losses). Also assessed are other elementary-event models with the aim of determining how sensitive the result is to the choice of different parameters that define the elementary event of interaction of primary particles with nuclei of the air. The coupling coefficients obtained do not differ greatly from those found by the author by means of extrapolation.

537.59

9464 24-HOUR VARIATION OF THE HARD COMPONENT OF COSMIC RADIATION AT MINIMUM OF SOLAR ACTIVITY. E.S.Glokova.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 243-51.

The anomalous behaviour of solar-diurnal variations is considered during minimum solar activity based on materials from 10 stations. The mean 24-hour variations were calculated for each month, with days having incomplete data excluded. A harmonic analysis was performed; the harmonic coefficients of the first harmonic were averaged for the seasons. In order to obtain the mean-year vectors, the seasonal vectors were averaged over the four seasons by the method of sliding means. Thus successive mean-year vectors of the separate seasons were obtained.

537.59

9465 ON THE DIURNAL VARIATION OF COSMIC-RAY INTENSITIES. H.Trefall.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 258-61.

Recordings of the hard and soft secondary cosmic-ray components performed in Bergen, Norway, from August to November, 1956 have been analysed for diurnal variations. The amplitude of the soft component was found to be about 50% greater than that of the hard component. The hard component was measured with several telescopes of different opening angles, but no significant differences were found between the corresponding amplitudes. However, the maximum of the diurnal variation observed with the most narrow-angle telescope ($\pm 6^\circ$ in the East–West plane) occurred about 3 hr earlier than with the vertical telescopes of larger opening angles. The amplitude observed with an east-pointing telescope was approximately 3 times greater than for the vertical telescopes, but the phase was not significantly different. The amplitude observed with a west-pointing telescope was the same as for the vertical telescopes, but the diurnal maximum occurs about 7 hr later.

537.59

9466 STRUCTURE OF THE CORE AND OF THE CENTRAL REGION OF AN EXTENSIVE AIR SHOWER AT SEA LEVEL. S.N.Vernov, Ya.S.Babetskii, N.N.Goryunov, G.V.Kulikov, Yu.A.Nechin, Z.S.Strugal'skii and G.B.Khristiansen.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 976-84 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 691-6 (Oct., 1959).

Experimental data on the lateral distribution of the energy flux of the electron–photon and nuclear-active components in the core and central region of extensive air showers are presented. It was found that appreciable fluctuations in this distribution occur in the core of the showers and, apparently, in the central region as well. The data indicate the existence of a specific correlation between the lateral distribution of the energy flux of the electron–photon component and that of the energy flux of the nuclear-active component in an individual shower.

537.59

9467 LATERAL DISTRIBUTION OF THE ENERGY FLUX OF THE ELECTRON–PROTON COMPONENT OF EXTENSIVE AIR SHOWERS.
V.A.Dmitriev, G.V.Kulikov, E.I.Massal'skii and G.B.Khristiansen.
Zh. eksper. teor. Fiz, Vol. 36, No. 4, 992-1000 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 702-8 (Oct., 1959).

Measurements are reported on showers with a total number of particles between 1×10^4 to 2×10^6 at sea level. The lateral distribution of the energy flux in the central region of the shower is found to agree with the calculations based on the cascade theory with age parameter of $s = 1.2$. It is shown that the energy flux of the electron–photon component decreases with the distance from the shower axis slower than the energy flux of the nuclear-active component. The energy carried by the electron–photon component in the central region of the showers is estimated.

537.59

9468 THE ANALYSIS OF HIGH-ENERGY SHOWERS. Ya.I.Granovskii and I.Ya.Chasnikov.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1119-22 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 795-7 (Oct., 1959).

The double-valued dependence of the shower particle energy on the angle of emission in the laboratory system is explained. A method is suggested for a more precise determination of γ_c, taking into account the energy and angular distribution of shower particles.

537.59

9469 DEVELOPMENT OF THE NUCLEAR-ACTIVE COMPONENT OF EXTENSIVE AIR SHOWERS.
S.N.Vernov, E.V.Gorchakov, I.P.Ivanenko and G.B.Khristiansen.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1233-9 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 877-80 (Oct., 1959).

The spectrum of the nuclear-active particles and the particle and absorption ranges are computed, and the rate of structure bursts is estimated, on the basis of certain simple assumptions regarding the nature of the elementary process. It is shown that an extensive air shower has certain characteristics that depend weakly on the nature of the elementary process, and certain characteristics that are sensitive to the latter.

537.59

9470 ANGULAR DISTRIBUTION OF SHOWER PARTICLES IN STARS PRODUCED BY HIGH-ENERGY PARTICLES.
L.A.San'ko, Zh.S.Takibaev, Ts.I.Shakhova and L.Ya.Balats.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 3-10 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 1-6 (Jan., 1960).

An analysis is carried out of the angular distribution of a unique star consisting of 20 + 15 + 59p, and probably produced by a proton of energy > 1000 BeV. The angular distribution of shower particles is characterized by two maxima and is explained by the anisotropic angular distribution and a power-law energy spectrum of the produced particles in the c.m.s. The presence of a large number of strongly ionized particles indicates that the Heitler–Terreaux theory does not give a correct description of π-meson production. The angular distribution of 11 other showers with the same characteristic anisotropy is also investigated.

537.59

9471 DECAY PROCESSES IN THE DEVELOPMENT OF NUCLEAR CASCADES IN THE ATMOSPHERE.
G.T.Zatsepin, S.I.Nikol'skii and A.A.Pomanskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 197-201 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 138-41 (Jan., 1960).

A general method is presented for the solution of the equations describing the cascade process for initial conditions prescribed at an arbitrary depth. The fraction of energy expended by cascade showers as a result of the $\pi \rightarrow \mu + \nu$ decay is estimated.

537.59

9472 INVESTIGATION OF A SHOWER CONSISTING OF 200 000 PARTICLES AND RECORDED IN A NUCLEAR PHOTOGRAPHIC PLATE. N.L.Grigorov and M.A.Kondrat'eva.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 684-9 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 3, 489-92 (March, 1960).

Electron-sensitive photographic plates were used to investigate the lateral and angular distributions of particles of a large shower that developed in lead. It is shown that, at a shower energy of the order of 4×10^{15} eV, the lateral distribution of all particles, and the angular characteristics of the particles in the central portion of the shower, are in agreement with the cascade theory.

537.59

9473 MICROSTRUCTURE OF THE CORE OF EXTENSIVE AIR SHOWERS.
S.N.Vernov, G.V.Kulikov, Z.S.Strugal'skii and G.B.Khristiansen.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1193-6 (Nov., 1959). In Russian

Experimental data are presented which indicate the presence of well-collimated particle beams in the cores of extensive air showers. Various possible explanations of the observed phenomenon are considered.

537.59

9474 INVESTIGATION OF THE HIGH-ENERGY μ-MESON FLUX IN EXTENSIVE AIR SHOWERS. S.N.Vernov, B.A.Khrenov and G.B.Khristiansen. Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1252-65 (Nov., 1959). In Russian.

Experimental data on the possible existence of narrow beams of μ-mesons (diameter in observation plane > 0.5 m) were obtained with the aid of an arrangement which allows simultaneous study of broad atmospheric showers on the earth's surface and underground. Data on broad atmospheric showers obtained at the earth's surface can be employed to study generation of narrow μ-meson beams.

537.59

9475 THE DIRECT PRODUCTION OF ELECTRON–POSITRON PAIRS BY ELECTRONS. V.A.Tumanyan. Zh. eksper. teor. Fiz., Vol. 38, No. 1, 264-5 (Jan., 1960). In Russian.

In the course of an investigation of high-energy cosmic-ray showers, 29 tridents were also seen. When these were analysed, and the results combined with those of other authors, agreement is found with the theory of Murota et al. (Abstr. 6873 of 1957) for the energy range 1-100 GeV of the primary electron. P.K.Kabir

537.59 : 539.12

BREMSSTRAHLUNG FROM COSMIC-RAY ELECTRON–PHOTON SHOWERS. See Abstr. 7324

537.59

9476 MEASUREMENTS OF THE MOMENTUM SPECTRUM AND OF THE POSITIVE EXCESS OF COSMIC-RAY PARTICLES AT SEA LEVEL. O.C.Allkofer. Z. Phys., Vol. 158, No. 3, 274-83 (1960). In German.

The momentum spectrum of cosmic-ray μ-mesons was studied in the region from 2×10^8 to 6×10^{10} eV. The particles were recorded by a parallel-plate spark counter mounted on a momentum spectrograph, the deflecting field being provided by a permanent magnet. The results obtained are in good agreement with previous work. Three values of the positive particle excess ratio have been obtained: $N_+/N_- = 1.38$, 1.36 and 1.15 at 1.3, 1.5 and 3.5 GeV/c, respectively. S.J.St-Lorant

537.59

9477 THE MOMENTUM SPECTRUM OF COSMIC RAYS AT A DEPTH OF 38 METRES WATER EQUIVALENT UNDERGROUND. F.Ashton, W.F.Nash and A.W.Wolfendale. Proc. Roy. Soc. A, Vol. 253, 163-76 (Nov. 24, 1959).

A direct determination was made of the cosmic ray spectrum underground at a depth of 38 m.w.e. under Castle Rock, Nottingham. The spectrum is based on measurements of 1010 particles traversing a magnetic spectrograph having a maximum detectable momentum of 8 GeV/c. By comparing this spectrum with the ground-level spectrum the energy loss of fast μ-mesons in penetrating the 38 m.w.e. of rock was determined. It is shown that the energy loss for μ-mesons in the momentum range 7 to 15 GeV/c is as expected by theory, the collision process being responsible for most of the loss.

537.59 : 523.74

9478 SOLAR ACTIVITY AND TRANSIENT DECREASES IN COSMIC-RAY INTENSITY. D.Venkatesan. J. geophys. Res., Vol. 64, No. 5, 505-20 (May, 1959).

The world-wide character of the intensity changes in meson and nucleon components is shown by a study of data from Ottawa, Churchill, and Resolute during the period October 1956 to December 1957. Further discussion is essentially restricted to the mean nucleonic component derived from the three stations. The investigation reveals an association between transient decreases in cosmic-ray intensity and the central meridian passage of active solar regions. On an average, the greater the activity rating of the regions, the larger is the cosmic-ray decrease. It is not possible, however, to discuss the relation specifically in terms of the characteristics of the regions, such as flares, sunspots, and the like. Further support for the relation comes from observation of geomagnetic data. Attention is drawn to the similarity between small as well as large transient decreases in intensity with regard to presence or absence of recurrence tendency. The study supports the view that both the 27-day variation and the Forbush events differ only in degree and could therefore be attributed to the same mechanism. It is possible to attribute the cosmic-ray decreases to beams of ionized rarified gas emitted from the sun and differing considerably in their characteristics.

537.59 : 523.74

9479 LOW-ENERGY COSMIC-RAY EVENTS ASSOCIATED WITH SOLAR FLARES. G.C.Reid and H.Leinbach. J. geophys. Res., Vol. 64, No. 11, 1801-5 (Nov., 1959).

As a result of the I.G.Y. riometer programme, it has been found that the measurement of ionospheric absorption in Arctic regions is a sensitive method of detecting low-energy cosmic rays associated with solar flares. The normal morphology of these events is described, and details are given of the 24 such events that have been detected in the period from May 1957 to July 1959. Two features have been noted: an apparent asymmetry in the distribution of cosmic-ray-producing flares across the solar disk; a pronounced degree of uniformity in the distribution of the radio-wave absorption over the terrestrial polar cap. These features are discussed, and tentative explanations are suggested.

537.59 : 523.75

9480 BALLOON FLIGHT INVESTIGATIONS OF PRIMARY COSMIC RAYS DURING SOLAR DISTURBANCES. M.A.Pomerantz, S.P.Agarwal and V.R.Potnis. J. Franklin Inst., Vol. 269, No. 3, 235-44 (March, 1960).

An extensive series of balloon flights was conducted during the peak of the present solar maximum, utilizing instruments identical with those which had been flown previously during the declining portion of the preceding solar cycle (1949-1952) — See Abstr. 4509 (1952); 4481 (1956). During the interval from July 1957 to September 1958, no sporadic increases in intensity were detected at Swarthmore, Pennsylvania, by quadrupole coincidence counter trains containing 86 g/cm² of absorber. In eight cases, solar flares of Importance 2 or greater occurred while the instruments were aloft, and on one occasion (22 Aug. 1958) a large increase in the flux of low energy cosmic rays was observed at balloon altitudes elsewhere. A recurrence tendency with a periodicity of 28 ± 1 days was followed for about 5 months. The fluctuations in the counting rates of the balloon-borne instruments were correlated with those observed by ground-based neutron monitors, and the mean factor relating the relative changes is 1.6 ± 0.3. However, it is unlikely that this ratio remains constant.

537.59

9481 RELATIONS BETWEEN THE VARIATIONS IN THE INTENSITY OF COSMIC RAYS AND THE STRUCTURE OF SOLAR ACTIVITY. A.Fréon, J.P.Legrand and M.Trellis. C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2550-12 (April 4, 1960). In French.

Details are given of cosmic-ray variations between April 1957 and August 1959. Measurements were made with neutron and meson detectors at Pic-du-Midi, and Timeil-Brevannes. The structure of the solar activity giving rise to the variations is discussed. C.F.Barnaby

537.59

9482 BALLOON OBSERVATION OF SOLAR COSMIC RAYS ON MARCH 26, 1958. P.S.Freier, E.P.Ney and J.R.Winckler. J.geophys. Res., Vol. 64, No. 6, 685-8 (June, 1959).

Data have been obtained by balloon flights on March 21, 26, and on April 8, 1958 near Minneapolis (geomagnetic latitude 55°) and are related to other cosmic ray events near that time. It is found that particles are present below the normal cut-off rigidities appropriate to the latitude, and that there is a delayed arrival of cosmic rays relative to the flare of March 23. It is suggested that the presence of low-rigidity particles indicates the distortion of the Stoermer cut-offs by the solar beam, and that the delayed arrival is due to a storage of particles accelerated during the solar flare. E.W.Kellermann

537.59

9483 OBSERVATIONS OF LOW-ENERGY SOLAR COSMIC RAYS FROM THE FLARE OF 22 AUGUST 1958. K.A.Anderson, R.Arnoldy, R.Hoffman, L.Peterson and J.R.Winckler. J. geophys. Res., Vol. 64, No. 9, 1133-47 (Sept., 1959).

Observations have been made of protons at balloon altitudes in the energy range 100 to 300 MeV following a solar sequence of

optical flare, r.f. noise bursts, and long-enduring noise storm. Other particles are shown to have low upper limits to their abundance. The flare particles continue to be observed for at least 2 days, and arguments are given to show that their storage and emission take place in the solar atmosphere. The differential energy spectrum is derived from ionization v. atmospheric depth data and is found to be E^{-3} dE. Observations by riometer and v.h.f. scatter propagation paths over the polar regions indicate that solar acceleration of protons up to roughly 100 MeV energy is rather frequent.

537.59

9484 INVESTIGATIONS IN CONNECTION WITH THE UNUSUAL INCREASE IN THE INTENSITY OF THE COSMIC RAY BACKGROUND IN THE MONTHS OF JULY AND AUGUST 1959. L.Holzapfel.
Naturwissenschaften, Vol. 47, No. 6, 130 (1960). In German.

Describes some experiments made to find the source responsible for the marked enhancement of the background cosmic ray activity in the summer months of 1959. S.J.St-Lorant

537.59

9485 HIGH-ALTITUDE COSMIC RAY MEASUREMENTS AT FORT CHURCHILL. I.B.McDiarmid and D.C.Rose.
Canad. J. Phys., Vol. 38, No. 5, 638-41 (May, 1960).

Measurements with rocket-borne Geiger counters have been carried out at altitudes up to 250 km at Fort Churchill, Manitoba. The total primary cosmic ray intensity at a time near a solar maximum has been determined and compared with other measurements taken at times of high solar activity and also with other Geiger counter measurements obtained near a solar minimum. A low-energy radiation was observed whose intensity increased with altitude up to about 25% of the primary intensity at 250 km.

537.59

9486 HEAVY NUCLEI FLUX IN THE PRIMARY COSMIC RADIATION AT A GEOMAGNETIC LATITUDE OF 31°N. K.I.Alekseeva and N.L.Grigorov.
Zh. eksper. teor. Fiz., Vol. 37, No.2(8), 380-8 (Aug., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York, Vol. 37(10), No. 2, 271-7 (Feb., 1960).

The flux of primary heavy particles in the stratosphere was measured with apparatus consisting of a telescope surrounded by hodoscope counters and of two pulse ionization chambers placed between the trays of the telescope counters. The ionization produced in each of the chambers by single particles with a charge $Z \geq 1$ traversing the telescope was measured. The flux of primary α-particles at the top of the atmosphere at a geomagnetic latitude of 31°N was found to be equal to 0.335 ± 0.035 particles $cm^{-2}min^{-1}$ $sterad^{-1}$, which is (16 ± 2)% of the total particle flux. The flux of primary particles with $Z > 2$ under similar conditions was found to be equal to 0.019 ± 0.006 particles $cm^{-2}min^{-1}sterad^{-1}$, which is ~ 6% of the number of α-particles and about 1% of the total particle flux at the top of the atmosphere at a geomagnetic latitude of 31°N.

537.59

9487 A COMPARISON OF THE COSMIC-RAY INTENSITY AT HIGH ALTITUDES WITH THE NUCLEONIC COMPONENT AT GROUND ELEVATION.
J.E.Henkel, J.A.Lockwood and J.H.Trainor.
J. geophys. Res., Vol. 64, No. 10, 1427-38 (Oct., 1959).

A series of balloon-borne soundings in the atmosphere with single Geiger tubes has been made during the period January to September, 1958. The counting rate determined at the Pfotzer maximum is compared with that recorded by the nucleonic detector at Mt. Washington (1909 m; $\lambda = 55°$N). Large changes in the counting rate of each detector were observed, and the ratio of these changes is $\sim 2:1$. Several large deviations from this normal ratio were also observed; they occur for flights on which the shape of the intensity-altitude curve near the Pfotzer maximum is quite different from the normal. The changes are explained either in terms of depressions of the low-energy portion of the cosmic-ray spectrum following marked decreases in the nucleonic component or by the presence of excess low-energy radiation. An anomalous increase of ~ 100% observed at high altitudes during one flight is attributed to high-energy X-radiation. It is found that the hemispherical average unidirectional intensity above the atmosphere derived from the counting rate at the Pfotzer maximum has decreased ~ 200% from 1954 to 1958 at $\lambda = 53°$N, and this change is compared with results at other latitides.

537.59

9488 COSMIC-RAY MEASUREMENTS IN THE VICINITY OF PLANETS AND SOME APPLICATIONS. I. PRIMARY COSMIC RADIATION. S.F.Singer and R.C.Wentworth.
J. geophys. Res., Vol. 64, No. 11, 1807-13 (Nov., 1959).

The variation of the primary cosmic-ray intensity is calculated as a function of distance from a dipole in its equatorial plane. Different values of spectrum exponent and of minimum momentum are chosen. Results are presented in a general form but are also specialized to the case of the moon. Scientific applications are indicated, such as determination of the cosmic-ray energy spectrum and low energy cutoff, cause of the "knee" and of Forbush decreases, value of the free space cosmic-ray flux, and determination of magnetic fields of the moon and the planets. The present paper deals only with the primary cosmic-rays.

537.59

9489 EVIDENCE FOR A FORBUSH TYPE OF DECREASE IN THE INTENSITY OF HEAVY NUCLEI OF THE PRIMARY COSMIC RADIATION. S.Biswas, P.J.Lavakare, K.A.Neelakantan. and P.G.Shukla.
Phys. Rev., Vol. 118, No. 2, 591-3 (April 15, 1960).

In an emulsion stack flown on March 13, 1956 from Iowa, the flux of heavy nuclei with $Z \geq 6$ in the primary cosmic radiation was measured as 15.8 ± 1.0 and 3.7 ± 0.6 particles/m^2sec sr for particles of kinetic energy ≥ 0.23 and ≥ 1.55 BeV/nucleon, respectively. The measured flux of energy ≥ 1.55 BeV/nucleon was 57 ± 11% lower than the normal flux. It is shown that almost the entire part of the reduction must be attributed to a large Forbush decrease of the cosmic radiation that occurred at the same time. The exponent of the integral energy spectrum of heavy nuclei ($Z \geq 6$) was measured as 1.78 ± 0.24 in the energy interval 0.23 to 9 BeV/nucleon. As this value is not significantly different from its normally measured value, it appears that the large reduction in the primary flux was not accompanied by any significant change in the energy spectrum.

537.59

9490 IONIZING RADIATION AT ALTITUDES OF 3500 TO 36 000 KILOMETERS. PIONEER I.
A.Rosen, C.P.Sonett, P.J.Coleman, Jr. and C.E.McIlwain.
J. geophys. Res., Vol. 64, No. 7, 709-12 (July, 1959).

The total ionizing component of cosmic radiation was measured on October 11, 1958 by means of an ionization chamber mounted on the Pioneer I lunar probe vehicle. Data were taken over an altitude range of 3500 to 36 000 km and a latitude range of 35°N to 5°N. The calibration procedure and the analysis of the telemetered data are described.

537.59

9491 NUCLEAR INTERACTIONS IN CARBON PRODUCED BY COSMIC RAYS WITH ENERGIES BETWEEN 10^{10} AND 10^{12} eV. L.F.Hansen and W.B.Fretter.
Phys. Rev., Vol. 118, No. 3, 812-24 (May 1, 1960).

An experiment is described in which high-energy nuclear interactions in the range of energies 10^{10}-10^{12} eV were analysed by means of a cloud chamber in a magnetic field. Measurements of ionization and momentum made possible the identification of electrons and mesons to about 20 BeV/c. Protons, K-mesons, and hyperons could not be identified unambiguously among themselves, except in very limited regions of momentum. The primary particles were cosmic-ray nucleons and a possible fraction of pions, the target nuclei were carbon, and the velocities of the primaries were determined from balance of momentum in the centre-of-mass system. A total of 41 events were analysed, and the results compared to previous experimental work and the predictions of the theories of Heisenberg and Landau. The measurements made included the transverse momenta of the secondaries and their average energy in the centre-of-mass system, the energy and angular distributions of the pions and heavy particles (protons, K-mesons, hyperons) in the centre-of-mass system, the inelasticity of the collision, the multiplicity of the showers, the percentage of strange particles, and the positive excess of the secondaries.

537.59

9492 [ELEMENTARY] INTERACTION BETWEEN 10^{11}-10^{12} eV [COSMIC-RAY] PARTICLES AND IRON NUCLEI. N.L.Grigorov, V.S.Murzin and I.D.Rapoport.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1068-79 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York),

Vol. 36 (9), No. 4, 759-66 (Oct., 1959).

The following characteristics, inter alia, were studied at an elevation 3860 m by means of apparatus which determined the "primary" particle energy: (a) the inelastic cross-section; (b) the degree of inelasticity of the interaction; (c) the distribution function of energy transferred to π^0-mesons.

537.59

9493 PRODUCTION OF K^+ MESONS BY COSMIC-RAY PROTONS AT 3250 m ABOVE SEA LEVEL.

M.Ya.Balats, P.I.Lebedev and Yu.V.Obukhov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 589-95 (Sept., 1959). In Russian. English translation in: Soviet Physics-JETP (New York), Vol. 37(10), No. 3, 417-21 (March, 1960).

The spectrum of K^+-mesons in the momentum range up to 0.9 GeV/c was measured at an altitude of 3250 m on Mt. Alagez. The cross-section for this process is estimated. Details are given of the experimental set-up.

537.59

9494 INVESTIGATION OF PION PRODUCTION IN INTERACTIONS OF [PRIMARY] COSMIC-RAY PROTONS AND ALPHA PARTICLES WITH CARBON NUCLEI IN THE STRATOSPHERE. K.I.Alekseeva, S.I.Brikker, N.L.Grigorov, V.S.Murzin and F.D.Savin.
Zh. eksper. teor. Fiz., Vol. 37. No. 3 (9), 596-603 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 422-7 (March, 1960).

Pulse ionization chambers and a hodoscope were used. The study was made at 31°N geomagnetic latitude. The electron cascade initiated in lead by γ-quanta from the decay of the neutral π-mesons produced was investigated. It was found that the primary-particle energy consumed in π^0 production in the interactions between protons, or α-particles, and carbon nuclei in the $\sim 10^{10}$ eV energy range is on the average $(10 \pm 3)\%$ and $(14 \pm 10)\%$, respectively.

537.59

9495 RATIO OF HYPERONS PRODUCED BY COSMIC RAYS. S.H.Hsieh.
Progr. theor. Phys., Vol. 18, No. 2, 209-10 (Aug., 1957).

The experimental results of Trilling and Leighton (Abstr. 3690 of 1957), which gave the production ratios of hyperons, are discussed and it is shown that these ratios are not inconsistent with those given by the Landau–Belenkii multiple production theory. C.F.Barnaby

537.59

9496 INVESTIGATION OF A HIGH-ENERGY INTERACTION IN A NUCLEAR EMULSION.

Kh.P.Babayan, M.G.Sarinyan and E.R.Tumanyan.
Zh. eksper teor. Fiz., Vol. 38, No. 2, 313-18 (Feb., 1960). In Russian.

A nuclear interaction, involving a star of the 5 + 21 p type produced by a cosmic primary particle of $\sim 10^{12}$ eV energy was investigated. An angular distribution of the secondary shower particles characterized by two maxima was obtained. This event is interpreted as a peripheral collision of two nucleons. The ratio of the number of neutral π-mesons to the total number of charged shower particles is found to be of the order of 0.4. A secondary interaction of the 0 + 6 p type was detected; it is probably due to a single πN-collision following a peripheral collision of nucleons.

539.14 : 536.48

SOME ASPECTS OF THE NUCLEAR ORIENTATION WORK AT OXFORD. See Abstr. 8963

539.14 : 539.12

INVESTIGATION OF THE STRUCTURE OF NUCLEI. See Abstr. 9348

539.14 : 539.18

NUCLEAR SHAPE EFFECT ON ISOMERIC SHIFT. See Abstr. 7721

NUCLEUS

539.14

9497 A NOTE ON THE CHARGE DEPENDENCE OF NUCLEAR FORCES. R.J.Blin-Stoyle and M.J.Kearsley.
Proc. Phys. Soc., Vol. 75, Pt 1, 147-9 (Jan., 1960).

Δ, the average difference between calculated and experimental values for the excitation of the first T = 1 states, is calculated for Li^6 taking into account the π^0, $\pi^\pm$ mass difference. It is shown that the calculated value of Δ is larger than observed experimentally and, that to reduce this value, electromagnetic renormalization of the pion–nucleon coupling constants must be considered. C.J.Batty

539.14

9498 THE PHASE FACTORS FOR THE TRANSITION FROM "PARTICLE" TO "HOLE" STATES IN THE NUCLEAR-SHELL THEORY. V.V.Balashov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1387-92 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 988-91 (Nov., 1959).

The method of second quantization, applied previously by Balashov et al. (1957) to the calculation of matrix elements for F and G operators of shell theory, is used to obtain a relation between fractional parentage coefficients of the beginning and the end of the shell. The change of the phase factors in the transition from "particle" to "hole" states is investigated. Selection rules for electromagnetic transitions in nuclei due to the symplectic group are found for the case of jj-coupling.

539.14

9499 NUCLEAR FORCES AND LEVELS OF THE LITHIUM ISOTOPES. V.V.Balashov.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1123-8 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 798-802 (Oct., 1959).

A refinement is introduced in the intermediate coupling model of the nuclear shell theory by taking into account paired spin–orbit interaction between the nucleons. Calculations carried out for Li^6 and Li^7 yield better agreement with experiment than the usual intermediate-coupling model which takes into account only single particle spin–orbit interaction. Some indications are obtained with respect to the existence of different types of radial dependence for nuclear forces of different exchange nature.

539.14

9500 SHELL EFFECTS IN THE OPTICAL POTENTIAL. A.Sugie.
Phys. Rev. Letters, Vol. 4, No. 6, 286-8 (March 15, 1960).

The model of Lane and Wandel is applied to a finite nucleus in order to explain some disagreements between low-energy neutron scattering data and predictions from the conventional optical potential, whose imaginary part (W) is independent of the mass number (A). It is found that W is dependent on A. A.M.Green

539.14

9501 THE INTRODUCTION OF COLLECTIVE COORDINATES FOR THE DESCRIPTION OF NUCLEI.

M.Jean and J.Touchard.
J. Phys. Radium, Vol. 19, No. 1, 8-9 (Jan., 1959). In French.

An attempt is made to account for the collective character of certain nuclear excitations by deriving the phenomenological Hamiltonian proposed by Bohr (Abstr. 4524 of 1952).

539.14

9502 COLLECTIVE DESCRIPTION OF Ne^{19} AND F^{17}. P.Lehmann, A.Lévêque, R.Barloutaud and T.Grjebine.
J. Phys. Radium, Vol. 19, No. 1, 44-5 (Jan., 1958). In French.

Experimental results on F^{17} and Ne^{19} support the collective description in this region.

539.14

9503 THE SHAPE OF EVEN–EVEN NUCLEI. A.S.Davydov and G.F.Filippov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1497-502 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1061-5 (Nov., 1959).

A nuclear model assuming a core plus two nucleons in a shell with angular momentum j is considered. The energy is determined

as a function of the parameters β and γ for various values of the total angular momentum of the nucleons. It is shown that the minimum energy in the ground state corresponds to a shape of the nucleus without axial symmetry, provided that $j > \frac{3}{2}$.

539.14

9504 MOMENTS OF INERTIA OF EVEN–EVEN RARE EARTH NUCLEI. J.J.Griffin and M.Rich.
Phys. Rev., Vol. 118, No. 3, 850-4 (May 1, 1960).

Moments of inertia of even–even nuclei are computed using the Nilsson model for deformed nuclei and the moment formula derived from the superconductor theory of nuclei. Values for the energy gap and the deformation are obtained from appropriate experimental data. Good agreement is found between the computed and observed energies of the first excited states of 26 rare-earth nuclei. This success lends strong support to the superconductor theory of the nucleus.

539.14

9505 SUPERFLUIDITY AND THE MOMENTS OF INERTIA OF NUCLEI. A.B.Migdal.
Zh. eksper. teor. Fiz., Vol. 37, No. 1 (7), 249-63 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 1, 176-85 (Jan., 1960).

A method is developed for the treatment of superfluidity of nuclei. A formula which agrees satisfactorily with experiment is obtained for the moment of inertia of a nucleus. An expression is found for the change in the energy of "pairing" in the transition from an even–even to an even–odd nucleus, and also for the change in the moment of inertia associated with this transition.

539.14

9506 PROPERTIES OF THE GROUND STATE OF DEFORMED NUCLEI. C.de Laet.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2350-2 (March 28, 1960). In French.

Argues that Geilikman's results (Abstr. 1702 of 1959) do not apply to even–even nuclei, and that Gottfried's conclusions on the stability of spheroidal deformations (Abstr. 8929 of 1956) are correct. R.J.N.Phillips

539.14

9507 GROUND STATES OF NON-SPHERICAL ODD NUCLEI ACCORDING TO THE INDEPENDENT PARTICLE MODEL. D.A.Zaikin.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 540-5 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37, No. 2, 381-5 (Feb., 1960).

The level scheme of nucleons in a spheroidal well with vertical walls is computed by using the asymptotic expansions of spheroidal wave-functions. The results obtained are in good agreement with the experimental data on the spins and parities of the ground and isomeric states of non-spherical odd nuclei.

539.14

9508 A STUDY OF THE STRUCTURE OF C^{13} USING THE TOTAL DISINTEGRATION $C^{13}(p,p')3\alpha$.
A.Samman and P.Cüer.
J. Phys. Radium, Vol. 19, No. 1, 13-15 (Jan., 1958). In French.

The existence of primary collisions $(p\text{-}\alpha,p')$ in the C^{12} nucleus is clearly demonstrated by a detailed study of about one hundred readily measurable events. The geometrical configurations of collision products gives the initial energy of the knocked-on α-particle in the nucleus and the average spectrum of this energy. The remaining Be^8 nuclei have excitation energies that can then be computed and seem reasonable.

539.14

9509 ATOMIC MASSES OF NUCLIDES FOR A = 70. F.Everling, L.A.König, J.H.E.Mattauch and A.H.Wapstra.
Nuclear Phys., Vol. 15, No. 2, 342-55 (Feb. 2, 1960).

Gives values of masses of nuclides up to A = 70. The values obtained are part of a new computation of atomic masses of nuclides from all known experimental data. Both mass spectrographic and nuclear reaction data have been used. L.L.Green

539.14

9510 ATOMIC MASSES AND BINDING ENERGIES OF NUCLEI WITH MASSES BETWEEN 186 AND 196. R.A.Demirkhanov, T.I.Gutkin and V.V.Dorokhov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1217-24 (Nov., 1959). In Russian.

Values of the masses and binding energies are presented for the nuclei of ismium, iridium, platinum, gold and mercury isotopes. The masses were measured with a mass spectrograph possessing a resolving power of 60 000-80 000. The masses were derived from doublets by direct comparison with the masses of corresponding organic compounds. The masses of 18 stable nuclides were measured and the masses of 18 radioactive nuclides were computed. The data thus obtained were used to evaluate the binding energy of nuclei, the binding energy per nucleon (E/A), the binding energies of the last neutron and proton (B_n and B_p) and the pair energies of neutrons and protons (P_n and P_p). For N = 116 the binding energy of nuclei was found to vary in a nonmonotonic manner for even as well as odd values of Z.

539.14

9511 THE BINDING ENERGIES OF ATOMIC NUCLEI. II. SELF-CONSISTENCY AND THE DEFINITION OF THE t-MATRIX. R.J.Eden, V.J.Emery and S.Sampanthar.
Proc. Roy. Soc. A, Vol. 253, 177-85 (Nov. 24, 1959).

The method for applying Brueckner theory to finite nuclei described in Pt I (Abstr. 1351 of 1960) is extended to improve the self-consistency and to take account of tensor forces. The equations are set up for the application of the method to O^{16} (see following abstract).

539.14

9512 THE BINDING ENERGIES OF ATOMIC NUCLEI. III. NUCLEAR FORCES AND THE GROUND STATE OF OXYGEN 16. R.J.Eden, V.J.Emery and S.Sampanthar.
Proc. Roy. Soc. A, Vol. 253, 186-98 (Nov. 24, 1959).

The r.m.s. radius and the binding energy of O^{16} are calculated for several different internucleon potentials. These potentials all fit the low-energy data for two nucleons, they have hard cores of differing radii, and they include the Gammel–Thaler potential (core radius 0.4 fermi). The calculated r.m.s. radii range from 1.5 f for a potential with core radius 0.2 f to 2.0 f for a core radius 0.6 f. The value obtained from electron scattering experiments is 2.65 f. The calculated binding energies range from 256 MeV for a core radius 0.2 f to 118 MeV for core 0.5 f. The experimental value of binding energy is 127.3 MeV. The 25% discrepancy in the calculated r.m.s. radius may be due to the limitations of harmonic oscillator wave-functions used in the unperturbed system.

539.14

9513 EMPIRICAL REGULARITIES IN THE NUCLEON PAIR PRODUCTION ENERGIES IN NUCLEI. V.A.Kravtsov.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1224-32 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 871-6 (Oct., 1959).

The variation of the pairing energies of nucleons and of the energy of the residual n–p interaction of odd nucleons is investigated on the basis of the most recent experimental data. It is found that the pairing energy depends not only on the total angular momentum of the nucleons but also on the position of the pair in the nuclear shell and on the deformation of the nucleus. The decrease in pairing energy with mass number A is slower than predicted by the theory. The pairing energy remains almost constant if two nucleons of different types and added to the nucleus. The energy of the residual n–p interaction of the odd nucleons is not zero, decreases with A, and is smaller than the pairing energy.

539.14

9514 NUCLEAR SPIN OF SAMARIUM-153. A.Cabezas, E.Lipworth, R.Marrus and J.Winocur.
Phys. Rev., Vol. 118, No. 1, 233-4 (April 1, 1960).

The atomic-beam magnetic-resonance method was used to measure the nuclear angular momentum of 47 hr Sm^{153}. It is found that $I = \frac{3}{2}$.

539.14 : 539.16

SPIN AND LEVEL DENSITY OF COMPOUND NUCLEI IN (n,γ) REACTIONS. See Abstr. 9594

539.14 : 536.48

NUCLEAR ALIGNMENT IN SOLID ^{3}He. See Abstr. 8884.

539.14

9515 NUCLEAR ALIGNMENT OF MANGANESE-56.
P.Dagley, M.A.Grace, J.M.Gregory and J.S.Hill.
Proc. Roy. Soc. A, Vol. 250, 550-61 (April 7, 1959).

The present work demonstrates the feasibility of aligning Mn^{56} produced by neutron irradiation of a nickel fluosilicate crystal containing stable Mn^{55}. Measurements were made of the angular distribution of the γ-radiation from the aligned Mn^{56} and also of the angular correlation of the γ-rays from this isotope. By combining the results it is possible to establish uniquely as 2 the spins of the states of the daughter nucleus of Fe^{56} at 2.66 and 2.98 MeV. The mixing ratios δ(E2/M1) for the 1.81 and 2.13 MeV γ-rays to the first excited state are shown to be 0.19 ± 0.02 and -0.28 ± 0.02. The spectrum of the γ-radiation was studied with a scintillation spectrometer and this leads to the following relative intensities; 0.845 MeV (100%), 1.81 MeV (27 ± 3%), 2.13 MeV (15 ± 3%), 2.55 MeV (1.2 ± 0.2%), 2.66 MeV (0.65 ± 0.1%), 2.98 MeV (0.35 ± 0.1%) and 3.4 MeV (0.22 ± 0.05%). Coincidence measurements suggested that the 2.55 and 3.4 MeV γ-rays are due to de-excitation of a level at about 3.4 MeV which decays both to the ground and first excited states. A spin of 2 for this state is proposed.

539.14

9516 MEASUREMENTS OF NUCLEAR MAGNETIC MOMENTS IN THE ALKALI EARTHS BY MOLECULAR BEAM MAGNETIC RESONANCE.
A.G.Kucheryaev, Yu.K.Szenov and Sh.M.Gogichaishvili.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 582-3 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 412-13 (Feb., 1960).

The magnetic moments of the nuclei Mg^{25}, Ca^{43}, Sr^{87}, Ba^{135} and Ba^{137} have been measured in S state atoms by the atomic beam method. The values agree with nuclear induction values.

J.G.Powles

539.14

9517 THE HYPERFINE SPLITTING OF THE $^2S_{1/2}$ GROUND STATE, AND THE NUCLEAR MAGNETIC DIPOLE MOMENT OF Au^{197}. G.Fricke, S.Penselin and E.Recknagel.
Naturwissenschaften, Vol. 47, No. 6, 129 (1960). In German.

Preliminary report. For complete account see following abstract.

539.14

9518 HYPERFINE SPLITTING OF THE $^2S_{1/2}$ GROUND STATE AND THE NUCLEAR MAGNETIC DIPOLE MOMENT OF Au^{197}. E.Recknagel.
Z. Phys., Vol. 159, No. 1, 19-32 (1960). In German.

Studied by the atomic beam magnetic resonance technique. A special high frequency arrangement is described. The hyperfine structure separation $\Delta\nu$ was determined from $\Delta F = 1$ transitions. The magnetic dipole moment μ_I was measured by a direct method. The experiments yield the following results:
$\Delta\nu(^2S_{1/2}) = (6099.309 \pm 0.010)$ Mc/s; $\mu_I(Au^{197}) = +(0.1431 \pm 0.0014)\mu_K$.

539.14 : 539.16

STATIC MOMENTS OF ODD-ODD NUCLEI. See Abstr. 7522

539.14

9519 DISTRIBUTION OF THE PROTON DENSITY IN A NUCLEUS WITH A GIVEN ORBITAL MOMENTUM.
L.P.Rapoport and S.G.Kadmenskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1303-7 (Nov., 1959). In Russian.

The density of protons in a nucleus possessing a given orbital momentum $\rho_l(r)$ is computed on basis of the experimental distribution of the total proton density $\rho(r)$. Spatial separation of nuclear shells is demonstrated by means of the distribution thus obtained.

539.14

9520 POLARIZATION OF NUCLEI OF DIAMAGNETIC ELEMENTS DISSOLVED IN IRON.
B.N.Samoilov, V.V.Skiyarevskii and E.P.Stepanov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 359-71 (Feb., 1960). In Russian.

The possibility of polarization of the nuclei of diamagnetic elements (indium, antimony and gold) in a weak solution in iron was established. Samples of the ferromagnetic alloys In–Fe, Sb–Fe and Au–Fe were cooled to about 0.03°K and magnetized to saturation by a small magnetic field (~ 2000 Oe). The anisotropy of γ-radiation of the In^{114m}, Sb^{122} and Au^{198} nuclei contained in the samples was measured. Measurements showed that a strong internal magnetic field acts on the nuclei dissolved in iron, and that the following limits can be established for the magnitude of this field: $H \geq 2.5 \times 10^5$ Oe for In; $H \geq 2.8 \times 10^5$ Oe for Sb and $H \geq 1.0 \times 10^6$ Oe for Au. It is suggested that this field is created by the conduction electrons which are considerably polarized in a ferromagnetic. At 0.03°K polarization of the nuclei studied is not less than 30 or 50%.

539.14 : 539.16

9521 POLARIZATION OF COBALT AND IRON NUCLEI IN FERROMAGNETS.
B.N.Samoilov, V.V.Skiyareskii and E.P.Stepanov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1366-7 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol 36(9), No. 5, 972-3 (Nov., 1959).

The anisotropy of gamma rays from Co^{60} in a magnetized cobalt–iron alloy (Permendur) was measured at temperatures from 0.03° to 0.1°K. The effective magnetic field strength $H = 2.5 \times 10^5$ was obtained at the cobalt nucleus. No gamma-ray anisotropy was detected in similar experiments on Fe^{59} nuclei in Armco iron cooled down to 0.02°K.

539.14

9522 EXCITATION OF ROTATIONAL NUCLEAR LEVELS BY CHARGED PARTICLES. A.D.Piliya.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1185-91 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 843-7 (Oct., 1959).

Scattering of charged particles by nuclei with large quadrupole moments is considered in the adiabatic approximation.

539.14

9523 SOME POSSIBLE APPLICATIONS OF RESONANCE SCATTERING OF γ-RADIATION.
I.Ya.Barit, M.I.Podgoretskii and F.L.Shapiro.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 301-2 (Jan., 1960). In Russian.

The Mossbauer effect (Abstr. 9040 of 1958; 1368 of 1960) in Ir^{191}, Zn^{67}, Ga^{67} is discussed as a possible tool for the measurement of Doppler, Zeeman and Einstein shifts. J.W.Gardner

539.14 : 539.2

9524 MÖSSBAUER EFFECT IN FERROCYANIDE.
S.L.Ruby, L.M.Epstein and K.H.Sun.
Rev. sci. Instrum., Vol. 31, No. 5, 580-1 (May, 1960).

The change in γ-ray transmission from a Co^{57} source with velocity was measured for an Fe absorber at room temperature, and a sodium ferrocyanide absorber at 80°K and at room temperature. A ferrocyanide source is expected to emit about 40% of 14.4 keV γ-rays without energy change, compared with 60% for soft iron.

J.Franks

539.14 : 539.2

9525 NUCLEAR RESONANCE ABSORPTION OF NON-DOPPLER-BROADENED GAMMA RAYS IN Re^{187}.
R.L.Mössbauer and W.H.Wiedemann.
Z. Phys., Vol. 159, No. 1, 33-48 (1960). In German.

The absorption was observed in Re^{187} bound in a crystal lattice. At 20°K, a small fraction of the gamma-quanta of the 134 keV transition to the ground state is emitted with essentially no energy lost to recoil, the recoil momentum being taken up by the entire crystal, not by the individual nucleus. Nuclei of Re^{187} similarly bound in a crystal lattice were irradiated with such gamma-rays emitted without loss of energy, resulting in an observable resonance absorption. Using a relative velocity of the order of 10 cm/sec, the line emitted with the natural line-width was shifted away from the absorption line, resulting in the destruction of the resonance phenomena. Analysis of the variation in transmission as a function of the Doppler shift of the emitted gamma-ray yields a value of $\tau = (1.5 \pm 0.2) \times 10^{-11}$ sec for the lifetime of the 134 keV excited state in Re^{187}.

539.14 : 539.17

9526 ENERGY LEVEL PARAMETERS FROM NUCLEAR RESONANCE FLUORESCENCE AT 7 MeV.
K.Reibel and A.K.Mann.
Phys. Rev., Vol. 118, No. 3, 701-13 (May 1, 1960).

The recoil-broadened photon spectrum from the reaction $F^{19}(p,\alpha\gamma)O^{16}$ was used to measure the elastic photon scattering

cross-sections at 7 MeV of 31 elements. The observed angular distributions are consistent with dipole transitions. A plot of the cross-sections versus mass number shows definite peaks around the closed shell regions near Z = 50, N = 82 (Sn, Te, and Ba), and Z = 82, N = 126 (Pb and Bi). For six medium and heavy elements self-absorption measurements were made which, when analysed in terms of a number of non-overlapping Breit–Wigner resonances, yield values of the average partial radiation widths to the ground states, the average total radiation widths, and the average level spacings for those elements. The radiation widths are significantly larger than those determined from slow-neutron scattering and capture experiments and, excepting Pb and Bi, the average level spacings are also appreciably greater than would be expected from the neutron data. The observed widths and spacings are in order of magnitude agreement with the recent interpretation of the modified single-particle calculation of Blatt and Weiskopf.

539.14 : 539.17

PROPERTIES OF LOW-LYING LEVELS OF RARE-EARTH NUCLEI. See Abstr. 7559

539.14 : 539.17 : 539.16

NUCLEAR ENERGY LEVEL DENSITY FROM (n,γ) REACTIONS. See Abstr. 9592

539.14

9527 EXCITED LEVELS OF EVEN–EVEN NUCLEI IN INTERMEDIATE REGIONS. M.Jean and J.Touchard.

J. Phys. Radium, Vol. 19, No. 1, 56-9 (Jan., 1958). In French.

The properties of the first excited levels of even–even nuclei belonging to intermediate regions, between closed shell nuclei and the spheroidal nuclei zone, are discussed in terms of quadrupole vibrations in the vicinity of a spherical equilibrium shape.

539.14

9528 VIBRATIONAL STATES IN DEFORMED EVEN-EVEN NUCLEI. R.K.Sheline.

Rev. mod. Phys., Vol. 32, No. 1, 1-24 (Jan., 1960).

This article contains a detailed discussion of vibrational energy levels of nuclei in the deformed nucleus regions near A = 150 and the actinide region. An attempt is made to predict the position of vibrational levels from the rotation–vibration correction to rotational bands. The identification of vibrational states and the systematics of vibrational energies as a function of neutron and proton number is discussed. A discussion is also given of perturbation of vibrational levels and consequent mixing of the bands and of the effects of this on selection rules and branching ratios. L.L.Green

539.14

9529 QUASI-STABLE STATES OF HIGH ISOTOPIC SPIN IN LIGHT NUCLEI. Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 278-80 (Jan., 1960). In Russian.

It is pointed out that isotopic spin selection rules may cause the neutron widths of low excited levels to be anomalously small in certain cases. P.K.Kabir

539.14

9530 THE ENERGY LEVELS OF ^{28}Al IN THE REGION OF 2 MeV. E.E.Baart, L.L.Green and J.C.Willmott.

Proc. Phys. Soc., Vol. 75, Pt 1, 154-7 (Jan., 1960).

The γ-rays feeding the states of Al^{28} near 2 MeV have been examined at several resonances in the reaction $Mg^{25}(p,\gamma)Al^{26}$. It is difficult to reconcile these γ-rays with just one level at Al^{26} observed in the reaction $Mg^{24}(He^3,p)Al^{26}$. L.L.Green

539.14

9531 SHELL MODEL ASSIGNMENTS FOR THE ENERGY LEVELS OF C^{14} AND N^{14}.

E.K.Warburton and W.T.Pinkston.

Phys. Rev., Vol. 118, No. 3, 733-54 (May 1, 1960).

Electromagnetic transition widths, reduced widths, and inelastic scattering cross-sections are calculated for the following states of N^{14} and C^{14}: (1) The levels arising from the ground-state configuration, s^4p^{10}, (2) the odd-parity levels arising from excitation of a 1p nucleon into the degenerate $2s_{1/2}$ and $1d_{5/2}$ shells, (3) the even-parity group of levels formed by excitation of two 1p nucleons into the 2s and 1d shells. The calculations for the s^4p^{10} configuration are carried out using the wave-functions of Elliott and of Visscher and Ferrell, and in jj coupling. The calculations for the odd-parity levels are done in the jj-coupling scheme. For the even-parity excited configuration an inert C^{12} core is assumed and M1 radiative widths are calculated for states arising from $s^4 + d^3 + sd$. The calculations are compared to the existing data. On the basis of this comparison shell-model assignments are proposed for 19 of the 27 known levels below 11-MeV excitation in N^{14} and for all the known levels in C^{14} below 9-MeV excitation.

539.14 : 539.16

Hg^{202} LEVEL SCHEME. See Abstr. 7539

539.14

9532 EXCITED STATES OF Mg^{25} AND Ca^{41}. G.Deconninck and A.Martegani.

Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 64-8 (March, 1960). In French.

The total neutron cross-sections of natural magnesium and calcium for D – D neutrons of energies 2.39 to 2.75 MeV have been measured. Resonances are observed and their interpretation is discussed. L.L.Green

539.14

9533 NEW EXPERIMENTAL DATA (OBTAINED FROM RADIOACTIVITY AND NUCLEAR REACTIONS) ON MOLYBDENUM ISOTOPES. AN ATTEMPT TO INTERPRET CERTAIN EXCITED LEVELS. C.Levi and L.Papineau.

J. Phys. Radium, Vol. 19, No. 1, 51-3 (Jan., 1958). In French.

New data indicate that the level distance $d\,\frac{5}{2}$–$g\,\frac{7}{2}$ is greater than 1 MeV and that the shell model alone cannot explain the lower levels.

539.14

9534 NUCLEAR ENERGY LEVELS OF Na^{24}. C.T.Hibdon.

Phys. Rev., Vol. 118, No. 2, 514-32 (April 15, 1960).

The neutron cross-section data up to 350 keV show a number of relatively large peaks and many smaller ones among the 86 peaks observed, the widths ranging from 0.2 to 6 keV. Approximately 50 small peaks were observed between 60 and 200 keV. Above 200 keV, each of the previously known peaks was resolved into two or more peaks and between these large peaks many narrower peaks were observed. The analyses show 9 s-wave levels and 46 p-wave levels, the remainder being d- and f-wave levels. A plot of the number of levels having energies $\leq E_n$ as a function of the neutron energy E_n shows an essentially linear distribution of the levels. As obtained from the reduced widths averaged over both values of J, the value of the strength function for $l = 0.06$; averaged over all values of J for $l = 1$ it is 0.65; and for higher values of l it is too large in comparison with the p-wave strength function. See also Abstr. 9681 of 1960.

539.14 : 539.17

9535 ENERGY LEVELS IN Ne^{20} FROM THE $F^{19}(d,n\gamma)Ne^{20}$ REACTION. J.W.Butler.

Phys. Rev., Vol. 118, No. 1, 222-7 (April 1, 1960).

The γ-ray threshold technique was used with the $F^{19}(d,n\gamma)Ne^{20}$ reaction to find excited states in the residual nucleus, Ne^{20}. Thin targets of CaF_2 were bombarded with deuterons from a 2 MV Van de Graaff accelerator. Two NaI(Tl) crystals (1.75 in. × 1.75 in. and 3 in. × 3 in.) were used in a coincidence arrangement to measure the γ-rays as a function of deuteron energy. Nine γ-ray or neutron thresholds were found, at bombarding energies of 0.51 ± 0.02, 0.60 ± 0.02?, 0.76 ± 0.02?, 0.85 ± 0.02?, 1.15 ± 0.02, 1.35 ± 0.02, 1.70 ± 0.02, 1.79 ± 0.02, and 2.06 ± 0.02 MeV. These threshold energies correspond to excited states in Ne^{20} at 11.11 ± 0.02, 11.19 ± 0.02?, 11.33 ± 0.02, 11.42 ± 0.002?, 11.69 ± 0.02, 11.87 ± 0.02, 12.19 ± 0.02, 12.27 ± 0.02, and 12.51 ± 0.02 MeV, respectively. All of these states decay principally to the ground state of Ne^{20} except the 11.11, 11.19, and 12.27 MeV states, which decay primarily to the 1.63 MeV state. Possible isobaric spin assignments are discussed.

539.14

9536 COLLECTIVE LEVELS IN THE EVEN–EVEN NUCLEI BETWEEN THE MASSES 182 AND 206.

R.Barloutaud, A.Lévêque, P.Lehmann and J.Quidort.

J. Phys. Radium, Vol. 19, No. 1, 60-3 (Jan., 1958). In French.

Reduced transition probabilities of the 2+ levels in W^{186}, Os^{188}, Os^{190}, Os^{192}, and Pt^{194} are deduced from Coulomb excitation experiments. 2+ level systems of even–even nuclei in this region are compared with the theory of vibrational levels.

539.14

9537 LOW LYING LEVELS OF P^{32} AND jj COUPLING. S.P.Pandya.
Progr. theor. Phys., Vol. 18, No. 6, 668-9 (Dec., 1957).

There is evidence of low-lying levels in P^{32} which conflict with jj-coupling theory. An attempt is made to explain this, using only small deviations from the jj limit. R.J.N.Phillips

539.14

9538 CONTRIBUTION OF THREE-PARTICLE FORCES TO THE BINDING ENERGY OF HYPER-NUCLEI.
V.A.Lyul'ka and V.A.Filimonov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1431-3 (Nov., 1959).
In Russian.

The three-particle Λ–nucleon potential is computed in the lowest order in meson theory. It is shown that in hyper-nuclei the contribution of the calculated potential to the Λ-particle energy is positive and insignificant in magnitude. The estimates thus obtained do not confirm Spitzer's conclusion (Abstr. 5285 of 1958) that three-particle forces play a large role in hyper-nuclei.

539.14

9539 NON-MESON DECAYS OF HYPERFRAGMENTS. I.B.Berkovich, A.P.Zhdanov, F.G.Lepekhin and Z.S.Khokhlova.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 423-5 (Feb., 1960).
In Russian.

Non-meson decays of 18 hyperfragments were studied in part of an emulsion stack irradiated with 4.5 BeV π-mesons. The ratio of the number of decays due to the interaction between a Λ^0-particle and a neutron to the number of decays due to interaction with a proton was found to be 1.25.

539.14

9540 NON-MESONIC DECAYS OF HYPERFRAGMENTS. I.B.Berkovich, A.P.Zhdanov, F.G.Lepekhin and Z.S.Khokhlova.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 604-11 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 3, 428-32 (March, 1960).

In a systematic scanning of 47 cm^3 of emulsion irradiated by 4.5 GeV π-mesons, 8 double stars were found which were attributed to nonmesonic decays of hyperfragments with Z = 2 to 6. In these stars, the connecting track thinned down and one of the secondary tracks had a range > 5000 μ. The hyperfragments, together with their secondary products, were identified. Possible decay schemes are proposed for the hyperfragments, assuming one neutron to be emitted.

539.14 : 539.12

EFFECT OF Λ^0 SIZE ON THE RATIO OF MESONIC TO NON-MESONIC DECAY OF $_{\Lambda}He^4$ HYPERFRAGMENTS. See Abstr. 9440

RADIOACTIVITY . NUCLEAR DECAY

539.16

9541 CORRECTION OF SAMPLE ABSORPTION OF RADIOACTIVITY. S.A.Berson and R.S.Yalow.
Science, Vol. 131, 606 (Feb. 26, 1960).

In the method presented here for the correction of sample absorption of C^{14} activity, the only requirement is the availability of any C^{14}-labelled compound of sufficiently high specific activity to permit addition, in negligible mass, of a number of counts equal to or greater than that in unknown samples and with solubility characteristics that exclude preferential layering during drying of samples. The principle may be applied to liquid scintillation counting. Absorption curves are dispensed with, and the weights of the assayed samples need not be determined.

539.16

9542 SOME PROPERTIES OF PARTICLES OF ABNORMALLY LONG RANGE EMITTED BY RADIOELEMENTS.
M.Ader and M.-P. C-bannes.
J. Phys. Radium, Vol. 19, No. 1, 106-7 (Jan., 1958). In French.

Natural polonium sources and artificial polonium sources from bismuth irradiated by neutrons, emit the same radiation, abnormally long and with the same characteristics. This radiation does not seem due to the presence of radioactive impurities in the sources. Emission of neutrons by the two sources is also observed.

539.16

9543 PRECISION OF THE DATING METHOD. STANDARDIZATION OF THE CALCULATION OF THE ERRORS AND OF THE MAXIMUM AGE IN THE C^{14} METHOD.
E.G.Crevecoeur, A.Vander Stricht and P.C.Capron.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 9, 876-90 (1959).
In French.

Because of the variety of ways that authors present the precision of their results when using the radiocarbon dating method, it is suggested that a standard technique be adopted for this purpose and such a technique is described. The relative importance of background radiation, counting time and activity are discussed and analysed. The minimum and maximum ages that can be determined by a given counter are also formulated, and the precision of the measurements is discussed in detail. C.F.Barnaby

539.16

9544 ANGULAR DISTRIBUTION AND ANGULAR CORRELATION OF THE RADIATIONS FROM NUCLEI WITH ORIENTED ELECTRON SHELLS. V.A.Dzhrbashyan.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1240-5 (April, 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 881-4 (Oct., 1959).

The effect of an oriented electron shell on the angular correlation of nuclear radiations is investigated. The angular distribution due to this effect is obtained.

539.16

9545 REDUCED WIDTHS FOR NUCLEON ASSOCIATION IN THE SHELL MODEL OF THE NUCLEUS.
V.V.Balashov, V.G.Neudachin, Yu.F.Smirnov and N.P.Yudin.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1385-9 (Nov., 1959).
In Russian.

Shell-model calculation of the reduced widths for compound-nucleus level decay involving emission of deuterons, tritons and α-particles is given.

539.16

9546 ACTIVITY OF ARSENIC OF HALF-LIFE 33 ± 1 s. C.Ythier.
C.R. Acad. Sci. (Paris), Vol. 250, No. 9, 1630-1 (Feb. 29, 1960).
In French.

The observation of a new isotope of arsenic is reported. This isotope, arsenic 81, was produced by the irradiation of selenium by 30 MeV neutrons. Its half-life was found to be 33 ± 1 sec. No details of the disintegration energies are given. C.F.Barnaby

539.16

9547 THE DELAYED COINCIDENCE METHOD. THE MEAN LIFETIME OF THE FIRST EXCITED STATE OF THE B^{10} NUCLEUS. S.Gorodetzky and A.Knipper.
J. Phys. Radium, Vol. 19, No. 1, 83-5 (Jan., 1958). In French.

The comparison method in delayed coincidence experiments is discussed and the fast coincidence circuit is described. The half-life $T_{1/2} = (8 \pm 2) \times 10^{-10}$ sec has been determined for the first excited state of B^{10}.

539.16

9548 DECAY OF Be^{8*} (2.43 MeV STATE). E.M.Henley and P.D.Kunz.
Phys. Rev., Vol. 118, No. 1, 248-62 (April 1, 1960).

The decay is treated theoretically. Of the open two-body decay channels all but one involve a nuclear state, the energy of which is not well defined. The usual formalisms have been generalized to take this into account. The estimate of the decay rates is made by means of a variational internal wave-function for the Be^{8*} state, based upon the alpha-particle model. It is found that the principal mode of decay is to $He^3 + He^4$. Model-dependent arguments are given to show that decay to the ground state of Be^8 should be inhibited. Furthermore, the momentum and angular distributions of alphas emitted in the decay through several two-particle decay modes are computed. These latter calculations do not assume any specific nuclear model, but depend on the weak assumption that the state is excited by a direct reaction. Comparison with recent measurements

indicates that, in addition to the $He^3 + He^4$ decay, approximately 7% of the decay occurs to the ground state of Be^7, which is consistent with these calculations.

539.16 : 539.17

PROPERTIES OF Fm^{246}. See Abstr. 7592

539.16

9549 THE PREPARATION OF A NEW ISOTOPE OF GALLIUM. C.Ythier.

C.R. Acad. Sci. (Paris), Vol. 250, No. 18, 3012-13 (May 2, 1960). In French.

Describes the method of chemical separation of radiogallium, produced by transmutation, which leads to the isolation of a new isotope of gallium, probably Ga^{70} with a half-life of 1.5 ± 0.5 min.

S.J.St-Lorant

539.16

9550 THE HALF LIFE OF In^{116}. A.Ducat and R.H.Thomas.

Nuclear Phys., Vol. 15, No. 3, 525-6 (March (1), 1960).

The half-life of In^{116} was measured by analysing the decay of activities following irradiation of In by moderated neutrons produced by a D-D source. Calculation of the weighted mean of a set of six independent measurements gave the result $\tau_{1/2}$ = 14.05 ± 0.26 sec.

R.E.Meads

539.16 : 539.17

SOME NEW RADIOACTIVE NUCLIDES IN THE RARE EARTH REGION. See Abstr. 9672

539.16

9551 IMPROVEMENT OF THE BACKGROUND IN SPECTROGRAPHY AND PROPAGATION OF SOURCES. G.Bastin-Scoffier and R.J.Walen.

J. Phys. Radium, Vol. 19, No. 5, 527-31 (May, 1960). In French.

A systematic study of the background of magnetic alpha spectra shows that the only factors of importance are : the absorption of the radioactive substance on its backing, the self-absorption and scattering in the spectrograph. By the use of very pure radioactive substances, very thin source backings and careful defining of the beam by slits, it has been possible to reduce the background by a factor of more than 100 and to detect with certainty the existence of groups of relative intensity 10^{-6}.

539.16

9552 EMITTERS OF α-PARTICLES WITH ENERGIES OF ABOUT 9 AND 12 MeV. V.A.Karnaukhov, V.I.Khalizev and G.N.Flerov.

Zh. eksper.teor. Fiz., Vol. 37, No. 5(11), 1266-72 (Nov., 1959). In Russian.

Lead was irradiated with accelerated oxygen and carbon ions. Nuclides emitting 11.8 ± 0.4 and 9.0 ± 0.3 MeV particles with half-life periods of approximately 1 min and 35 ± 10 sec respectively were detected among the reaction products. Identification of these nuclides are discussed.

539.16

9553 HALF-LIFE OF Pb^{210}. W.R.Eckelmann, W.S.Broecker and J.L.Kulp.

Phys. Rev., Vol. 116, No. 3, 698-701 (May 1, 1960).

A new determination of the half-life of Pb^{210} was made by the geological method. $PbCl_2$ extracted from uranium minerals in secular equilibrium was used to calibrate a thick-source scintillation counter for Po^{210} alpha particles. Using this calibration the absolute activity of Po^{210} in partial equilibrium with a known number of Pb^{210} atoms prepared from the decay of a measured quantity of radon was determined. From these data a half-life of 21.4 ± 0.5 years was obtained for Pb^{210}.

539.16

9554 LIFETIME OF THE 241 keV STATE OF ^{220}Tn. J.G.Siekman and G.T.Pott.

Physica, Vol. 25, No. 2, 179-81 (Feb., 1959).

The lifetime of the 241.1 keV state in Tn^{220} which is formed by α decay from ThX has been measured by a delayed fast coincidence technique using the α's feeding the level and the 142.2 keV K-conversion electrons de-exciting it. A lifetime of $4.5 \pm 1.6 \times 10^{-10}$ seconds was obtained and an intrinsic quadrupole moment of $|Q_0| = 3.0 \pm 0.6 \times 10^{-24}$ cm^2 obtained for the nucleus Tn^{220}. Ll.Green

539.16

9555 ALPHA SPECTRA FROM THE DECAYS OF Li^8 AND B^8. B.J.Farmer and C.M.Class.

Nuclear Phys., Vol. 15, No. 4, 626-35 (March (2), 1960).

The spectra of alpha-particles accompanying the dissociation of Be^8, following the beta-decays of Li^8 and B^8, were measured. The spectra were found to be essentially identical, confirming the expected symmetry in the decay schemes of Li^8 and B^8. The spectrum associated with the decay of Li^8 was compared with that given by the modified single level of Wheeler (1941). The spectrum is not adequately accounted for by this formula if current values of the parameters are used to describe the 2^+ and 4^+ levels at 2.9 and 11.7 MeV in Be^8 which are assumed to be participating. An alternative description of the alpha-spectrum, involving only the 2+ levels in Be^8 at 2.9 and 16.7 MeV, was given recently by Biedenharn and Griffy (see following abstract). Their expressions are found to be in agreement with the data over an energy range of more than 10 MeV, and hence may be taken as the preferred description of the process.

539.16

9556 BETA DECAY INVOLVING THE $Be^{8*}(2^+)$ STATE. T.A.Griffy and L.C.Biedenharn.

Nuclear Phys., Vol. 15, No. 4, 636-45 (March (2), 1960).

The shape of the alpha- and beta-spectra in the $Li^8(\beta^-,\alpha)\alpha$ and $B^8(\beta^+,\alpha)\alpha$ decay is calculated directly from alpha–alpha scattering phase-shifts, using methods developed for this purpose, and the assumption that the decays involve only Be^{8*} in a (2^+) intermediate state. Recent experimental results are in good agreement with the calculated spectra (see preceding abstract).

539.16

9557 EXPERIMENTS ON THE β-DECAY OF POLARIZED NUCLEI. E.Ambler, R.W.Hayward, D.D.Hoppes and R.P.Hudson.

Physica, Vol. 24, Supplement, S64-S68 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). The experiments so far performed on the β-decay of polarized nuclei are discussed; the essential part of the cryogenic apparatus is then described, together with the results of work on Mn^{56}.

L.Mackinnon

539.16

9558 A NOTE ON PRESENT KNOWLEDGE OF THE β-INTERACTION. R.Nataf.

J. Phys. Radium, Vol. 19, No. 1, 32-3 (Jan., 1958). In French.

It is shown that a VAST interaction, where ST is associated with a "right-handed" neutrino, and VA with a "left-handed" one, leads to the maximum "longitudinal" polarization of β-particles, which agrees with all the present conclusive experimental evidence on β-decay of the nuclei.

539.16

9559 BACKSCATTERING OF CARBON-14 BETA RADIATION. G.L.Gaines,Jr.

J. appl. Phys., Vol. 31, No. 4, 741-2 (April, 1960).

The increase in count rate from evaporated films of C^{14} (max. β ray energy = 0.15 MeV) when backscattering plates Al, Cu and Pt are used is found to be in close agreement with those from Tl^{204} (E_{max} 0.76 MeV) when the absorption correction to zero counter-window thickness is made.

J.R.Mallard

539.16

9560 A STUDY OF THE LEVELS IN ^{19}F FOLLOWING THE β-DECAY OF ^{19}O. C.M.P.Johnson, G.A.Jones, W.R.Phillips and D.H.Wilkinson.

Proc. Roy. Soc.A, Vol. 252, 1-15 (July 7, 1959).

The β-decay scheme of O^{19} to states of F^{19} was determined, and log ft values assigned to the individual transitions, by studying the γ-rays following β-decay. The decay schemes of the levels in F^{19} were elucidated by coincidence and angular correlation measurements. These measurements have enabled characteristics to be assigned to the excited states of F^{19}, and relative γ-transition probabilities have been determined. The results are compared with theoretical calculations on the individual-particle model in intermediate coupling and on the collective model.

539.16

9561 THE β-ASYMMETRY OF POLARIZED ^{52}Mn NUCLEI AND THE γ-ANISOTROPY OF ALIGNED ^{166}Ho NUCLEI. H.Postma, A.R.Miedema and M.J.Steenland.
Physica, Vol. 24, Supplement, S155 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The measurements of the β^+-asymmetry of Mn^{52} by the annihilation method, reported in Madison, favoured spin I = 6 for Mn^{52}. These measurements were not too accurate and therefore have been repeated by direct detection of the β-particles in a lightpipe cryostat. The disadvantage of a lightpipe cryostat is that the Compton electrons are also detected. A relatively large asymmetry is found, which may be explained by a mixing of the Gamow–Teller-interaction with Fermi-interaction, but the interpretation is somewhat difficult because of the evaluation of f_1 in the case of Mn^{52}. The circular polarization experiments gave a value of f_1, which is larger than would be calculated from the γ-anisotropy. This reduces the mixing ratio of the G.T.-interaction with Fermi-interaction. By indirect cooling (see Abstr. 8966 of 1960) alignment of Ho^{166} in crystals of yttrium ethyl sulphate was obtained. Anisotropy of the 720 and 820 keV γ-rays was found. The γ-rays of 180 and 275 keV showed a smaller anisotropy.

539.16

9562 PROTACTINIUM-237. K.Takahashi and H.Morinaga.
Nuclear Phys., Vol. 15, No. 4, 664-77 (March (2), 1960).

Protactinium-237 was produced from the reaction $U^{238}(\gamma,p)Pa^{237}$ by 25 MeV bremsstrahlung. The activity produced was chemically separated with the aid of a recoil method from fission products. The half-life of this new isotope was found to be $T_{\frac{1}{2}}$ = 39 ± 3 min. The radiations were measured with a scintillation spectrometer. Three beta-components were identified with the end-points of 2.30 ± 0.05 MeV, 1.35 MeV, and about 0.6 MeV. Many gamma-rays were also found. A decay scheme was constructed with the aid of Nilsson's unified model.

539.16

9563 THE β- AND ELECTRON SPECTRA OF RaD [Pb^{210}]. J.Tousset and A.Moussa.
J. Phys. Radium, Vol. 19, No. 1, 39-40 (Jan., 1958). In French.

A study of the electron spectrum of Pb^{210} above 3 keV. The two nuclear β-spectra of 15 and 61 keV have been separated from the Auger L electrons. The fluorescence and Auger yields of the L shell have been measured.

539.16

9564 LONGITUDINAL POLARIZATION OF β-RAYS. A STUDY OF Sr^{90} AND S^{35}. H.Langevin-Joliot and N.Marty.
J. Phys. Radium, Vol. 19, No. 1, 28-31 (Jan., 1958). In French.

The apparatus used to study the polarization of the electrons from Sr^{90}(ΔJ = 2 yes) and S^{35}(ΔJ = 0 no) is described. Taking account of the thickness of the source and scatterer, the results agree with a negative polarization equal to v/c.

539.16

9565 THE DECAY OF Ta^{180}. H.Daniel.
Z. Naturforsch., Vol. 15a, No. 3, 264-5 (March, 1960). In German.

Upper limits are placed on the transition probabilities for possible β-decay of Ta^{180} to the 0.100 MeV level and to the ground state. S.J.St-Lorant

539.16

9566 POSITRON SPECTRUM OF Eu^{152} AND Eu^{152m}. S.F.Antonova, S.S.Vasilenko, M.G.Kaganskii and D.L.Kaminskii.
Zh. eksper. teor. Phys., Vol. 37, No. 3(9), 667-71 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 477-80 (March, 1960).

A low-background β-spectrometer was employed. It was found that the β^+-decay of Eu^{152} takes place to the first (2^+) and second (4^+) excited states of Sm^{152}. The end-point energies of the partial spectra are 713 and 470 keV and their intensities are respectively 1.4×10^{-4} and 5×10^{-5} β^+ per decay. Formation of Sm^{152} in the ground and first excited states occurs in the positron decay of the Eu^{152m} isomer. The end-point energies of the partial spectra are 890 and ~ 770 keV and the intensities are respectively 6×10^{-5} and 2×10^{-5} β^+ per decay. The excitation energy of the Eu^{152} isomer is deduced from the difference of the endpoint energies of the β^+ spectra and is found to be (55 ± 6) keV. Pair conversion coefficients and the multipolarities of a number of γ-transitions are derived from the positron internal pair conversion spectra.

539.16

9567 POSITRON DECAY OF Ir^{192}. S.F.Antonova, S.S.Vasilenko, M.G.Kaganskii and D.L.Kaminskii.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 379-83 (Feb., 1960). In Russian.

Positron decay of Ir^{192} was discovered ($T_{1/2}$ = 74 days). Relative decay intensity amounts to 1.5×10^{-7} positrons per decay. End-point energy of the β^+-spectrum E_0 = (240 ± 10) keV. Total transition energy of Ir^{192}–Os^{192} equals 1950 keV. The conversion electron spectrum in the energy region of more than 1 MeV was obtained. A new γ-transition was discovered with the energy E_γ = 1088 keV.

539.16

9568 ISOMERISM OF SILVER-108. M.A.Wahlgren and W.W.Meinke.
Phys. Rev., Vol. 118, No. 1, 181-3 (April 1, 1960).

A long-lived isomer of Ag^{108m} has been detected in old Ag^{110m} samples. The isomer decays with a half-life ≈5 years. Gamma- and beta-ray spectrometer data show that 90% of the disintegrations proceed by electron capture followed by a cascade of three gamma rays of 616, 722, and 434 keV energy, while 10% go by isomeric transition to Ag^{108}. New values are given for the branching ratios of 2.4 min Ag^{108}.

539.16

9569 RADIOACTIVE DECAY OF Lu^{169}. R.G.Wilson and M.L.Pool.
Phys. Rev., Vol. 118, No. 1, 227-8 (April 1, 1960).

Ytterbium oxide enriched to 30.9% in the 168 mass number was irradiated with 6 MeV protons. An activity decaying by electron capture with a half-life of 7.1 ± 0.2 min was produced and assigned to Lu^{169}. The activity consists of γ-rays with energies of 87 ± 1, 900 ± 7, 987 ± 7, 1410 ± 20, 1800 ± 40, 2130 ± 60 keV in addition to the ytterbium K X-ray. An energy level scheme for this decay is presented.

539.16

9570 RADIOACTIVE DECAY OF Lu^{172}. T.G.Wilson and M.L.Pool.
Phys. Rev., Vol. 118, No. 4, 1067-72 (May 15, 1960).

Ytterbium oxide enriched to 95.9% in mass number 172 was irradiated with 6 MeV protons. An activity decaying by electron capture with a half-life of (6.70 ± 0.04) days was produced and its assignment to Lu^{172} confirmed by the indentification of the ytterbium K X-ray and by comparison with the activities produced by similar proton irradiations of the other enriched isotopes of ytterbium. The 4.0 hr positron activity previously assigned to Lu^{172} was not observed and is best attributed to an impurity. The observed activity of Lu^{172} consists of the L and K X-rays of ytterbium and gamma rays with energies of 79, 91, 113, 182, 203, 270, 324, 373, 490, 527, 697, 809, 900, 912, 1093, 1402, and 1583 keV. Because no positron radiation exists in the activity of Lu^{172}, the mode of decay is solely by electron capture to Yb^{172}. Gamma–gamma coincidence measurements, energy considerations, and consideration of the relative numbers of the radiations observed in the activity of Lu^{172} have led to the assignment of energy levels at 530 (6+), 1172(3+), 1263 (4+), 1375 (5+), 1662 (3–), (1699), and 2072 (4+) keV in Yb^{172} in addition to the previously known 78.7(2+) and 260.2 (4+) keV levels. The positions of all of the observed radiations and some observed only in conversion electron measurements are shown in a proposed energy-level scheme for the decay of Lu^{172}. Approximate branching ratios for the electron capture disintegrations of Lu^{172} are also shown in the level scheme. Few, if any, electron capture transitions of Lu^{172} occur to the ground and first excited states of Yb^{172}. Of the two predicted spins for the ground state of Lu^{172}, 4– is more consistent with the proposed energy-level scheme.

539.16

9571 ISOMERIC LEVEL IN Pb^{206} FORMED IN THE DECAY OF Bi^{206}. S.H.Vegors, Jr and R.L.Heath.
Phys. Rev., Vol. 118, No. 2, 547-53 (April 15, 1960).

An activity of 4.8 msec half-life which is assigned to Pb^{206} was observed in the electron capture decay of 14.5 day Bi^{206}. This

isomeric level decays with the emission of 987.8, 703.3, and 284.4 keV gamma rays with relative transition intensities of 100, 10 and 10. No other gamma rays of energy greater than 10 keV were observed in the decay of this isomer. The 284.4 and 703.3 keV gamma rays are in coincidence but neither is in coincidence with the 987.8 keV transition. This evidence suggests that the 987.8 keV level de-excites directly to the ground state by the emission of a 284.4, 703.3 keV cascade with a 987.8 keV cross-over. There is some evidence (not conclusive) that the 987.8 keV level itself may not be isomeric but that it may be fed entirely by a highly converted low-energy transition (<100 keV) from an isomeric level.

539.16

9572 DECAY OF Sm^{155}. R.E.Sund, R.G.Arns and M.L.Wiedenbeck.
Phys. Rev., Vol. 118, No. 3, 776-80 (May 1, 1960).

Sm^{155} was found to decay to Eu^{155} with a half-life of 21.9 ± 0.2 min. Internal conversion electrons corresponding to the gamma rays in Eu^{155} were observed in a magnetic spectrometer. The gamma ray spectrum was studied with a well crystal. The spectra of gamma rays coincident with the X-ray, 104, 142 and 246 keV gamma rays were observed. A number of new, weak transitions are proposed. Directional correlation measurements were made on the 142–104 keV cascade. Possible spin assignments are discussed.

539.16

9573 NUCLEAR PAIR EMISSION FROM THE 7.656 MeV LEVEL IN C^{12}. D.E.Alburger.
Phys. Rev., Vol. 118, No. 1, 235-42 (April 1, 1960).

For previous work, see Abstr. 405 of 1960. The 7.656 MeV nuclear pair transition from the 0+ second excited state of C^{12} was observed in the $Be^{9}(\alpha,n)C^{12}$ reaction by means of an intermediate-image pair spectrometer. With a beam of 5.81 MeV α-particles incident on a 0.7 MeV thick Be foil target the observed intensity ratio of the 6.545 MeV pair line to the 4.433 MeV pair line from the 2+ first excited state of C^{12} was $(4 \pm 1.5) \times 10^{-4}$. Approximately the same intensity ratio was found with both 5.38 and 5.81 MeV α-particles incident on thick (6 mg/cm^2) Be targets. By applying the appropriate factors for the spectrometer efficiency and for the internal pair conversion coefficient of the 4.433 MeV transition the derived ratio of pair to total widths of the 7.656 MeV level is $I_{\pm}/I = 8.2 \times 10^{-7} \times R$ where $R = N_{4.433}/N_{7.656}$, the ratio of neutron populations in the $Be^{9}(\alpha,n)C^{12}$ reaction. As a rough estimate R is assumed to be ~8 based on the only information available. This leads to $I_{\pm}/I \sim 7 \times 10^{-6}$ which is a factor of ~15 smaller than estimates by Cook et al (Abstr. 1924 of 1958) in which the width I_{α} for the α-particle decay of the level was taken as $\frac{1}{10}$ of the Signer limit. The most plausible explanation of the data is that I_{α} is close to the Wigner limit.

539.16

9574 AUGER SPECTRUM OF THE L_{III} SHELL OF BISMUTH. K.Risch.
Z. Phys., Vol. 159, No. 1, 89-100 (1960). In German.

A thin Bi layer was irradiated by X-rays so that L-Auger electrons were emitted. A magnetic lens spectrometer was used to measure the electron spectrum. Energy, transition, and relative intensity are given for 14 lines. Under the most favourable conditions, the number of L_{III} ionizations is about ten times that of L_{II} ionizations. In this case, only a small intensity of L_{II}-Auger electrons is superposed on the L_{III}-Auger spectrum. The ratio d of intensities of line group $L_{III}MN$ to line group $L_{III}MM$ is found by extrapolation to be d = 0.46 ± 0.02. This, combined with earlier results, gives an L_{III}-Auger yield $a_3 = 0.64 \pm 0.04$. The L_{III} fluorescence yield is $\omega_3 = 0.36 \pm 0.04$, correspondingly. A further application of the experimental method is described.

539.16

9575 RADIATIVE TRANSITIONS BETWEEN ROTATIONAL LEVELS IN SPIN 1/2 NUCLEI. D.F.Zaretskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1129-32 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 803-5 (Oct., 1959).

The relative intensities of electric and magnetic transitions between rotational levels in spin $\frac{1}{2}$ nuclei are considered. The calculation is based on the coupling scheme previously proposed by the author. As an example, the Tm^{169} nucleus is considered. It is shown that the observed intensity ratio does not contradict the proposed coupling scheme.

539.16

9576 DEVIATIONS FROM THE $\Delta T = 0$ ISOTOPIC SPIN SELECTION RULE IN FERMI TRANSITIONS. C.C.Bouca C.C.Bouchiat.
Phys. Rev., Vol. 118, No. 2, 540-6 (April 15, 1960).

Experimental deviations from the $\Delta T = 0$ isotopic spin selection rule have been observed experimentally in $J \rightarrow J$ beta transitions. In the theory of a vector interaction with a conserved current these deviations have to be explained only in terms of isotopic spin impurities, while in the conventional theory exchange mesonic currents may also induce Fermi transitions with $\Delta T \neq 0$. In this paper an attempt is made to estimate the contribution of the isotopic spin impurities arising from the Coulomb interaction between the protons. The j–j coupling shell model is used to calculate the relevant Coulomb matrix elements. When all the nucleons outside the core are in the same orbi orbit the main contribution comes from the Coulomb interaction between the protons outside the core. A comparison between the empirical Fermi matrix element MF and the calculated one is performed in the case of Mn^{52}, Sc^{44}, and Na^{24}. The two quantities agree fairly well for Mn^{52}. No such an agreement is found in the two other cases, the predicted M_F being too large for Na^{24} and too small for Sc^{44}, at least by a factor ten. This discrepancy may reflect the inadequacy of the j–j shell model to describe the Coulomb effects or the presence of mesonic effects. More experiments are needed to make a choice between these two possibilities.

539.16

9577 SECOND FORBIDDEN COULOMB BETA TRANSITIONS. Yu.V.Gaponov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 154-8 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 109-12 (Jan., 1960).

From a classification of the terms appearing in the series expansion of the β-decay interaction Hamiltonian, rules are obtained which make it possible to predict which nuclear matrix elements contribute to β-transitions of a given type, and to estimate the values of these elements. It is shown that there exists a simple case of second forbidden Coulomb transitions, $\Delta j = 2$ (no), with properties similar to those of unique transitions. The angular β–ν correlation, the β–γ correlation with circularly polarized γ-quantum, and the spectrum are found for this case.

539.16

9578 INTENSITY RULES FOR BETA TRANSITIONS TO DIFFERENT ROTATIONAL STATES OF EVEN–EVEN DAUGHTER NUCLEI. A.S.Davýdov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 137-42 (July, 1959). In Russian. English translation in : Soviet Physics – JETP (New York), Vol. 37(10), No. 1, 98-101 (Jan., 1960).

Relative probabilities are computed for the β-decay of an odd–odd nucleus with excitation of different rotational states of the non-axially-symmetric even–even daughter nucleus. The theory is compared with experimental results for the β-decay of Re^{188}, Np^{238}, Eu^{154}, Re^{186} and Ir^{190}.

539.16

9579 ANGULAR DISTRIBUTION AND POLARIZATION OF β-PARTICLES IN SECOND FORBIDDEN TRANSITIONS. A.Z.Dolginov and E.V.Kharitonov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 776-85 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 553-9 (March, 1960).

Explicit formulae for the polarization and angular distribution of β-particles in second forbidden transitions involving V and A coupling are derived. The angular correlations in unique transitions are examined in the case of arbitrary order of forbiddenness. Unique second forbidden transitions are treated in detail.

539.16

9580 E2 + M1 MIXED TRANSITIONS IN HEAVY ODD A NUCLEI. M.Kawamura.
Progr. theor. Phys., Vol. 18, No. 1, 87-9 (July, 1957).

Ratios of the intensities of E2 and M1 decays from first excited states are tabulated. The behaviour of the mixing ratio, from nucleus to nucleus, is tentatively discussed. Some suggestions concerning nuclear structure and transition mechanisms are made.

E.A.Sanderson

539.16

9581 POSSIBILITY OF A TEST OF THE CONSERVED VECTOR CURRENT THEORY IN THE A = 8 POLYAD.
H.A.Weidenmüller.
Phys. Rev. Letters, Vol. 4, No. 6, 299-302 (March 15, 1960).

The M1 and E2 amplitudes for the transition from the lowest J = 2, T = 1 level in B^8 to the first excited state, J = 2, T = 0, of Be^8 are evaluated by an intermediate coupling calculation, limits being placed on the free parameters by fitting the magnetic moment of Li^8 and the beta decay rate. These values are then used to place limits on the B–α angular correlation in the decay of B^8, for both the conserved vector current theory of beta decay and the original Fermi theory. The results, when compared with experiment, slightly favour the Fermi theory but, owing mainly to the possible error in the evaluation of the E2 rate, this cannot be regarded as conclusive evidence.
E.J.Squires

539.16

9582 ELECTRIC QUADRUPOLE γ TRANSITIONS IN EVEN–EVEN NUCLEI. N.N.Delyagin.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 849-51 (Sept., 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 37(10), No. 3, 605-6 (March, 1960).

It is shown that the reduced probabilities B(E20 for the first excited 2+ states of even–even nuclei, which decay by electric quadrupole radiation, follow the relationship log B(E2) = a log E + b where E is the energy of the excited state. Some possible reasons for this rule are discussed.
C.J.Batty

539.16

9583 DECAY OF THE $i_{13/2}$ STATE IN Pb^{205}.
R.Stockendal.
Phys. Rev., Vol. 118, No. 4, 1074-6 (May 15, 1960).

The L_I, L_{II}, L_{III}, M_I, M_{II}, M_{III}, M_{IV}, N_I, N_{III}, and O_I conversion lines of a 26.22 ± 0.01 keV transition in Pb^{205} have been found from studies with electromagnetically separated samples of Bi^{205}. The transition, having M2 character, most probably takes place from a 4 msec $i_{13/2}$ state of 1014.0 keV to the 987.6 keV $\frac{9}{2}$- state, thus causing the latter state to appear metastable, as has earlier been reported. This suggestion is also supported by strong evidence for the existence of a 310.5 keV E3 transition between the isomeric state and the 703.3 keV state. The energy 1014.0 keV of the $i_{13/2}$ state coincides with a transition energy in Pb^{205} earlier reported, and is found to fit well into the energy systematics of the $i_{13/2} \rightarrow F_{5/2}$ M4 transitions in the odd lead isotopes.

539.16

9584 ISOMERIC TRANSITION IN Pb^{205}.
D.E.Alburger.
Phys. Rev., Vol. 118, No. 4, 1076-80 (May 15, 1960).

A(26 ± 1) keV transition in Pb^{205} occuring in the electron capture decay of Bi^{205} has been indentified from its L,M, and N internal conversion electrons measured in an intermediate-image beta-ray spectrometer. By using NaI scintillation detectors behind the source in the spectrometer the M and N lines of the 26 keV transition are found to be not in coincidence with electron-capture K X-rays but they are in coincidence with a principal gamma ray of 1 MeV and weak components of ~0.7 and ~0.3 MeV. Since the Bi^{205} gamma rays of 987.8 and 284.2 keV and a fraction of the 703.3 keV gamma rays have been shown by Vegors and Heath (Abstr. 9571 of 1960) to be delayed with respect to electron-capture K X-rays with a half life of 4.8 msec, the present coincidence results indicate that the delayed radiation is associated with the 26 keV transition originating from an isomeric state in Pb^{205} at 1013.8 keV. The 26 keV transition is probably a quadrupole and a possible assignment is M2 if the spin-parity assighment of the 987.8 keV level is $\frac{9}{2}$- and if the 1013.8 keV level is the $\frac{13}{2}$+ state predicted at 1.1 MeV by Pryce. The possibility that all or part of the known 1014.2 keV gamma radiation constitutes the "missing" M4 transition in Pb^{205} is discussed.

539.16

9585 FORBIDDEN ELECTRIC DIPOLE TRANSITIONS IN THE $Tb^{161} \rightarrow Dy^{161}$ DISINTEGRATION. M.Vergnes.
J. Phys. Radium, Vol. 19, No. 1, 36-8 (Jan., 1958). In French.

Three photons of 25.5, 49 and 74.5 keV were found. The first two form a cascade, the third one being the cross-over. Two levels are thus defined at 25.5 and at 74.5 keV. The periods of these levels have been measured. The measurement of the conversion coefficients allows the determination of the nature of the two transitions of 25.5 and 74.5 keV, as both being E1 (+M2). The probabilities of these two transitions are very small compared with those obtained by the formula of Weisskopf. A level scheme is given.

539.16

9586 FORBIDDEN TRANSITIONS IN THE DEFORMED Tu^{169} NUCLEUS. É.E.Berlovich, V.N.Klement'ev, V.G.Fleisher, O.V.Larionov, F.Sh.Murtazin and D.A.Apostolov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1202-6 (Nov., 1959). In Russian.

Lifetime values of $(3.6 \pm 0.1) \times 10^{-8}$ sec and $(6.7 \pm 0.2) \times 10^{-7}$ sec were obtained by delayed coincidence measurements for the 379 and 316 keV levels of the Tu^{169} nucleus. The partial probabilities for eight transitions were determined on basis of these data and from the relative transition intensities from both levels and the multipolarity ratios. For the 177 keV (E2), 177 keV (M1), 198 keV (E2), 198 keV (M1), 308 keV (E2), 240 keV (E1) and 260 keV (E1) transitions which are forbidden with respect to the projection of the total angular momentum on the deformation axis, the delay factor is 10^3-10^4 per unit forbiddenness, a value which differs significantly from the usual value (10-100). The 63 keV (E1) transition which is forbidden with respect to the projection of the orbital and spin momenta and also with respect to the quantum number characterizing oscillations along the deformation axis is less probable by five orders of magnitude than that predicted by Weisskopf's estimation. However, it is in good qualitative agreement with Nilsson's calculation of the probability for deformed nuclei.

539.16

9587 A STUDY OF SOME γ-TRANSITIONS IN THE Si^{30} NUCLEUS BY THE REACTION $Si^{29}(d,p)Si^{30*}(\gamma)Si^{29}$.
S.Gorodetzky, T.Muller, M.Port and G.Bergdolt.
J. Phys. Radium, Vol. 19, No. 1, 49-50 (Jan., 1958). In French.

The branching ratios for the second excited state are: 99.5% of the transitions are direct to the ground state; 0.5% are through the first excited state. For the third excited state these values are respectively, for the direct transition, greater than 40%; for the cascade transition through the first excited state less than 60%.

539.16

9588 MULTIPOLARITIES OF GAMMA TRANSITIONS IN Tm^{169}.
V.M.Kel'man, R.Ya.Metskhvarishvili, B.K.Preobrazhenskii, V.A.Romanov and V.V.Tuchkevich.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 639-42 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 3, 456-8 (March, 1960).

The ratios of the internal conversion coefficients of 63, 94, 110, 130.5, 177 and 198 keV γ-quanta in the L-subshells of Tm^{169} were found. From these data, a determination was made of the multipolarities of the transitions and, in the case of mixed radiations, the percentages of components in the mixture.

539.16

9589 DIRECT DETERMINATION OF INTERNAL CONVERSION COEFFICIENTS. P.Mukherjee.
Phys. Rev., Vol. 118, No. 3, 794-8 (May 1, 1960).

Using the same source and instrument geometry, both the external as well as internal conversion lines of the 1.17 and 1.33 MeV gamma rays of Co^{60} were scanned in a Siegbahn–Slätis spectrometer. From the known internal conversion coefficients of these gamma rays, the instrument is calibrated for the direct determination of internal conversion coefficient of any other gamma rays having energy near 1.3 MeV. As an example, the internal conversion coefficient of the 1.408 MeV gamma ray, in the decay of Eu^{152}, is measured. The value obtained is 4.99×10^{-4}.

539.16

9590 ANGULAR CORRELATION OF INTERNAL BREMSSTRAHLUNG AND SUCCESSIVE NUCLEAR GAMMA-RAY IN THE RADIATIVE K-CAPTURE.
Y.Koh, O.Miyatake and Y.Watanabe.
Progr. theor. Phys., Vol. 18, No. 6, 663-5 (Dec., 1957).

The usefulness of this type of measurement is discussed, and it is suggested that there might be circumstances when it is more useful than experiments on the corresponding angular correlation of beta-rays. Explicit expressions for the angular correlation are given for the case of K-capture followed by E2 gamma-ray emission. Numerical values are given for Y^{89}.
E.J.Squires

539.16

9591 ALLOWANCE FOR MULTIPLE SCATTERING IN A CYLINDRICAL [γ-RAY] SOURCE.

E.E.Kovalev and V.I.Popov.

Zh. tekh. Fiz., Vol. 27, No. 7, 1621-3 (July, 1957). In Russian.

Standard reactor shielding theory is applied to calculate the γ-ray build-up factor due to the "self-scattering" (including absorption) in a cylindrical source in which γ-rays are produced uniformly and isotropically. J.W.Gardner

539.16 : 551.5

THE INCREASE OF γ-RADIATION FROM THE GROUND IN SWEDEN (1950-1959) CAUSED BY FALLOUT FROM NUCLEAR WEAPON TESTS. See Abstr. 8433

539.16 : 539.17 : 539.14

9592 SPECTRA OF γ-RAYS PRODUCED IN THE CAPTURE OF THERMAL NEUTRONS BY HEAVY NUCLEI. I.

L.V.Groshev, A.M.Demidov and V.I.Pelekhov.

Zh. eksper. teo. Fiz., Vol. 38, No. 2, 588-97 (Feb., 1960). In Russian.

The experimental data on the γ-spectra from the thermal neutron (n,γ) reaction are compared with the theoretical spectra calculated for two laws of variation of the level density. The effect of an energy gap in the level spectrum of even–even nuclei on the γ-ray spectrum in the 0.8–4 MeV region is discussed. The presence of an energy gap leads to large difference in the spectra of odd–odd and even–even nuclei.

539.16 : 539.17 : 539.14

9593 SPECTRA OF γ-RAYS PRODUCED IN CAPTURE OF THERMAL NEUTRONS BY HEAVY NUCLEI. II.

V.W.Strutinskii, L.V.Gtoshev and M.K.Akimova.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 598-611 (Feb., 1960). In Russian.

The spectra of γ-rays accompanying capture of thermal neutrons are calculated. The calculations are performed for dipole γ-radiation and two types of dependence of the nuclear level density on energy. The results obtained for the level density are compared with data derived from other experiments.

539.16 : 539.14

9594 CIRCULAR POLARIZATION OF γ-QUANTA ACCOMPANYING NUCLEAR CAPTURE OF SLOW NEUTRONS.

D.P.Grechukhin.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 621-30 (Feb., 1960). In Russian.

An estimate is made of the order of magnitude of the polarization and anisotropy of the angular distribution of cascade quanta emitted by a previously polarized compound nucleus. Determination of the average of the circular polarization over the cascade permits one to establish the spin of the initial state of the compound nucleus and by investigating the spectral distribution of the polarization and anisotropy of the angular distribution of the quanta one can obtain information on the spin dependence of the level density of the compound nucleus.

539.16

9595 ANISOTROPIC DISTRIBUTION OF INTERNAL BREMSSTRAHLUNG γ-QUANTA FROM K-CAPTURE BY POLARIZED NUCLEI. S.F.Timashev and V.A.Kaminskii.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 284-5 (Jan., 1960). In Russian.

The angular distribution has the form : $1 + P\alpha \cos\theta$ where P is the polarization factor $\langle J_z \rangle / J$ and α is expressible in terms of the matrix elements for the various Lorentz-invariant interactions. A general formula is given for α and applied to several examples in which the only interactions present are vector and pseudo-vector. J.W.Gardner

539.16

9596 HIGH-ENERGY GAMMA RADIATION FROM Ag^{110m}.

H.W.Taylor and S.A.Scott.

Canad. J. Phys., Vol. 38, No. 4, 573-5 (April, 1960).

A report of scintillation counter observations between 1.3 and 1.8 MeV, made in search of a weak gamma-ray component. R.J.N.Phillips

539.16 : 539.1

9597 RESONANCE SCATTERING OF GAMMA-QUANTA ON Cd^{114} NUCLEI. N.N.Delyagin.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1177-82 (Nov., 1959). In Russian.

The lifetime of the first excited state of the Cd^{114} nucleus (556 keV) was measured by the γ-quantum resonance scattering method in which a gaseous In^{114} source (as $InCl_3$) was used. The value $\tau = (1.42 \pm 0.21) \times 10^{-11}$ sec for the lifetime of the level satisfactorily agrees with the Coulomb excitation data. The interrelationship between reduced transition probabilities for even-even cadmium isotopes and the excitation energy is discussed.

539.16

9598 NUCLEAR ALIGNMENT OF ^{58}Co AND ^{60}Co.

R.I.Hulsizer, W.J.Huiskamp, J.C.Wheatley and A.C.Anderson.

Physica, Vol. 24, Supplement, S155 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements were made of the γ-rays emitted by Co^{58} and Co^{60} nuclei aligned in the same single crystals of $Cu_{0.20}Zn_{0.80}Co_{trace}Rb_2(SO_4)_2.6H_2O$. The purposes of the measurements were to determine the angular momentum characteristics of the beta-decay of Co^{58} and to study experimentally the validity of neglecting interionic interactions in interpreting the results. Using a two-stage demagnetization technique the crystals were cooled to $1/T^* = 160$, and the counting rates for both Co^{58} and Co^{60} were measured as a function of $1/T^*$ for several angles, including 90°, with respect to the alignment axes.

539.16

9599 γ-RADIATION AT AIR–GROUND INTERFACES WITH DISTRIBUTED Cs^{137} SOURCES.

C.E.Clifford, J.A.Carruthers and J.R.Cunningham.

Canad. J. Phys., Vol. 38, No. 3, 504-7 (March, 1960).

The radiation dose from fallout is affected by scattering and absorption of the ground material. Measurements have been made of this effect, and also of the polar distribution of the radiation around the source for smooth clay earth, concrete and lead as ground materials. The results are compared with calculations. At a height of 1 metre above a uniformly contaminated plane 73% of the total dose is due to radiation received within ±20° of the horizon; ground roughness would affect this in the practical case of fallout.

539.16

9600 DECAY OF 1.25 MINUTES NUCLEAR ISOMER Dy^{165m}.

R.Tornau.

Z. Phys., Vol. 159, No. 1, 101-11 (1960). In German.

The decay of Dy^{165m} (produced by thermal neutron bombardment of Dy_2O_3) was studied with the aid of scintillation spectrometers. The ratio of cross-sections for activation of Dy^{165m} (1.25 min) and Dy^{165} (2.3 h) was found to be 0.654 ± 0.017. The K-conversion coefficient of the 108.0 keV γ-ray of Dy^{165m} was determined to be $\alpha_K = 3.62 \pm 0.22$, agreeing well with the theoretical value for de-excitation by E3 transition. The branching ratio of the decay of Dy^{165m} is (97.6 ± 0.3)% isomeric transition leading to the Dy^{165} ground state and (2.4 ± 0.3)% β-decay leading to excited states of Ho^{165}. The β-ray spectrum was measured and is composed of two components with maximum energies 890 ± 50 keV (87 ± 5%) and 1020 ± 80 keV (13 ± 5%). The most probable spin assignments for the 515 and 356 keV states of Ho^{165} are 3/2⁻ and 3/2⁺, respectively.

539.16 : 539.1.07

THE MEASUREMENT OF SEVERAL SOFT γ-RAY LINES IN THE NEUTRON CAPTURE BY EUROPIUM, BY MEANS OF A CRYSTAL SPECTROMETER. See Abstr. 9671

539.16

9601 SOME ASPECTS OF THE DECAY SCHEME OF 54 MINUTE ^{116}In. R.K.Girgis and R.van Lieshout.

Physica, Vol. 25, No. 7, 590-6 (July, 1959).

The gamma-rays following the decay of 54 min In^{116} were examined with the help of scintillation spectrometers. A detailed analysis of the direct spectrum was performed. Coincidence relations were established by the summing method. The results were found to be in agreement with those reported by Siiltis, du Toit and Siegbahn (Abstr. 587 of 1951). The existence of the disputed 1.8 MeV gamma-ray was confirmed and a level at 3.07 MeV in Sn^{116} is proposed as the origin of this gamma-ray. The presence of a 3.08 MeV peak in the summing spectrum supports this interpretation.

539.16

9602 γ-SPECTRUM OF La^{140} IN THE ENERGY RANGE 2300-3900 keV.

B.S.Dzhelepov, B.A.Emel'yanov, K.P.Kupriyanova and Yu.N.Podkopaev.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 282-4 (Jan., 1960). In Russian.

Gamma-ray spectrometer measurements were made of gamma-ray energies in the range 2300 keV - 3900 keV associated with the reaction $La^{139}(n, \gamma)La^{140}$. Major peaks were identified at 2860 keV and 3090 keV, and a subsidiary peak at 3360 keV; after instrumental corrections these were allocated to lines at 2915 keV, 3110 keV and 3380 keV. J.W.Gardner

539.16

9603 ISOTOPES Np^{240} AND Np^{241}. R.M.Lessler and M.C.Michel.

Phys. Rev., Vol. 118, No. 1, 263-4 (April 1, 1960).

The 1 hr neptunium activity which had previously been assigned to Np^{241} has been identified as the lower isomer of Np^{240}. The decay energy of the 1 hr Np^{240} has been found to be 2.05 MeV compared with 2.18 MeV for that of the 7.3 min Np^{240}. Gamma-rays of energies 1160, 1000, 915, 595, 565, 435, 245, 160, and 85 keV have been found to be associated with the decay of Np^{240}. The best value for the half-life of Np^{240} is 63 ± 2 min. The isotope Np^{241} has been found to have a 16 min half-life with strong evidence for an isomer with a 3.4 hr half-life.

539.16

9604 STUDY OF THE EXCITED LEVELS OF Po^{214} (RaC). G.R.Bishop and F.Madaule.

J. Phys. Radium, Vol. 19, No. 1, 41-3 (Jan., 1958). In French.

Coincidence measurements on the γ-rays and β-rays of Po^{214} lead to a decay scheme. Spins and parities of the excited states are proposed on the basis of angular correlation studies, internal conversion coefficients and β-ray lifetime determination. There is evidence of collective model effects for this nucleus.

539.16

9605 NEW NEUTRON-DEFICIENT ISOTOPES OF TANTALUM. K.T.Faler and J.O.Rasmussen.

Phys. Rev., Vol. 118, No. 1, 265-9 (April 1, 1960).

Bombardment of Ho_2O_3 with N^{14} ions in the Berkeley heavy-ion linear accelerator has resulted in the discovery of new isotopes of tantalum which have been assigned as Ta^{170} and Ta^{176}. They have half-lives of 3.7 and 1.3 hr, respectively. Ta^{172} was not observed and is believed to have a half-life shorter than 30 min. Gamma-ray spectra have been obtained for these two isotopes and for Ta^{170}. Ta^{170}, with an 11 hr half-life, has also been produced by 48 MeV alpha-particle bombardment of Lu_2O_3, and its conversion-electron spectrum was studied. From these data a decay scheme is proposed using nine of the observed transitions and assigning spins to three members of the ground-state rotational band.

539.16

9606 ANGULAR CORRELATION OF TWO MIXED γ-RAYS OBTAINED BY COULOMB EXCITATION. V.P.Gillet.

J. Phys. Radium, Vol. 19, No. 1, 64-5 (Jan., 1958). In French.

Exact computation is made of the correlation of two mixed gamma rays following Coulomb excitation in order to determine some general characteristics of triple correlation processes. The nucleus chosen is Ta^{182} and the dependence of the maximum anisotropy as a function of the reduced matrix elements of the second emitted gamma is given.

539.16

9607 GAMMA-RAY INTENSITIES IN THE THORIUM ACTIVE DEPOSIT. G.T.Emery and W.R.Kane.

Phys. Rev., Vol. 118, No. 3, 755-62 (May 1, 1960).

The relative intensities of the gamma rays of the descendants of radiothorium were studied by measuring the photoelectron spectra from thorium and platinum foils. The relative sensitivity of the arrangement at different energies was found by using other surces having gamma rays of known relative intensity. Comparison of the measured gamma-ray intensities with the measurements by others of internal coversion intensities allows internal conversion coefficients to be computed and the multipolarities of several transitions to be determined. An electric monopole transition was found in Po^{212}. The gamma-ray intensities are used to find the intensities of beta-ray branches. Gamma-ray intensities are compared with the known intensities of long-range alpha particles from Po^{212} and transition probabilities are estimated for some electromagnetic transitions between states of that nucleus. The level scheme of Po^{212} and Pb^{208} are discussed in the light of the information found here and of other recent information.

NUCLEAR REACTIONS

539.17

9608 SOME IDEAS ON THE THEORETICAL INTERPRETATION OF CATALYZED NUCLEAR REACTIONS. S.Vuccino.

C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2702-4 (April, 1960). In French.

Existing theories are discussed and the author proposes improvements in the calculation of the nuclear wave function. The weakness of theories relating the study of mesonic molecules to that of the hydrogen molecule is discussed. S.E.Hunt

539.17

9609 DIRECT INTERACTION IN NUCLEAR REACTIONS. C.T.De Dominicis.

J. Phys. Radium, Vol. 19, No. 1, 1-7 (Jan., 1958). In French.

A brief introductory account of the shortcomings of the compound nucleus model and what can be expected from processes involving interactions lasting a very short time.

539.17

9610 THE THEORY OF DIRECT NUCLEAR REACTIONS INVOLVING POLARIZED PARTICLES. G.L.Výsotskii and A.G.Sitenko.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1143-53 (April, 1959). In Russian. English translation in: Soviet Physics--JETP (New York), Vol. 36(9), No. 4, 812-18 (Oct., 1959).

The theory of direct nuclear reactions (stripping and pick-up reactions) involving polarized particles is considered. The angular distributions and polarizations of the products of direct nuclear reactions induced by polarized particles in oriented nuclei are determined by the distorted wave method without inclusion of the spin--orbit coupling.

539.17

9611 OPTIMUM TARGET ORIENTATION IN NUCLEAR REACTION EXPERIMENTS. J.Rosenblatt.

Rev. sci. Instrum., Vol. 31, No. 5, 578-9 (May, 1960).

The relation between the energy loss in the target and the manner in which the energy loss of the incident particle is transmitted to the outgoing particle is discussed. S.J.St-Lorant

539.17

9612 EXPANSION OF THE AMPLITUDE OF A REACTION INVOLVING FORMATION OF THREE LOW-ENERGY PARTICLES IN POWERS OF THRESHOLD MOMENTUM. I.T.Dyatlov.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1330-6 (Nov., 1959). In Russian.

It is demonstrated that the linear terms and those quadratic terms of the threshold momenta powers which specify the angular distributions, can be obtained by considering the analytical properties of the amplitude.

539.17

9613 PERIPHERAL COLLISIONS OF HIGH-ENERGY NUCLEONS. V.M.Maksimenko.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 306-7 (Jan., 1960). In Russian.

The probabilities W_{mn} of emitting m charged particles forward and n backwards are calculated and compared with experiment. The mechanism of the interaction is taken to be the formation of an isobar in either the (3/2, 3/2) state or in a higher state of T = 1/2 and energy 1.64 Mc^2. The decay scheme for the second isobar is calculated from the statistical model. D.W.L.Sprung

539.17

9614 EXCITATION OF VIBRATIONAL LEVELS IN NUCLEI BY CHARGED PARTICLES. A.D.Pilya.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1434-40 (Nov., 1959). In Russian.

Excitation of the first vibrational level of an even-even nucleus by charged particles possessing energies close to the height of the Coulomb barrier is considered.

539.17

9615 SURVEY OF (p,d) REACTIONS AT 22 MeV. C.D.Goodman and J.B.Ball.

Phys. Rev., Vol. 118, No. 4, 1062-6 (May 15, 1960).

Energy spectra of deuterons from (p,d) reactions on medium and heavy weight elements were surveyed. The experimental method of particle identification is described. The spectra show gross structure indicative of strong selection rules. The gross structure can be correlated with nuclear shell structure, and the levels which are most strongly excited are those which have the same shell configurations as the target with one neutron missing. Angular distributions confirm the shell assignments. This leads to a picture of the reaction mechanism for (p,d) reactions in which the incoming proton interacts principally with a single neutron rather than with the nucleus as a whole.

539.17

9616 EXCITATION OF NUCLEAR COLLECTIVE STATES IN CHARGED PARTICLE SCATTERING. S.I.Drozdov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 499-502 (Feb., 1960).
In Russian.

Differential excitation cross-section of the 4^+ even–even nucleus collective level in fast nucleon small-angle scattering is derived. The cross-section depends strongly on the absolute value and sign of the nuclear shape parameter α_4.

539.17

9617 SECONDARY STARS CREATED BY THE INTERACTION OF 8.7 BeV PROTONS WITH THE NUCLEI OF PHOTOGRAPHIC EMULSIONS.
G.B.Zhdanov, P.K.Markov, V.N.Strel'tsov, M.I.Tret'yakova, Chzhen Pu-In [Cheng P'u-Ying] and M.G.Shafranova.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 611-15 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 3, 433-6 (March, 1960).

The secondary interactions of fast neutrons, protons and π-mesons in an emulsion stack bombarded with 8.7 GeV protons were studied. It was found that, on an average, 0.68 ± 0.07 fast neutrons were created in a star. The fast nucleons carried away (55 ± 9)%, and the fast π-mesons (33 ± 9)%, of the energy of the primary particle.

539.17

9618 NUCLEAR INTERACTIONS OF 8.7 BeV PROTONS IN PHOTOGRAPHIC EMULSIONS.
G.B.Zhdanov, V.M.Maksimenko, M.I.Tret'yakova and M.N.Shcherbakova.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 620-33 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37 (10), No. 3, 442-51 (March, 1960).

Inelastic interactions were studied and, in particular, the interaction cross-section, multiple production of particles and their angular distribution. From a comparison with calculations based on the statistical theory, some conclusions are drawn concerning the existence of interactions of the peripheral (nucleon–nucleon) type, as well as the role of secondary interactions inside a complex nucleus.

539.17 : 539.12

9619 CHARGED π-MESON PRODUCTION IN THE INTERACTION BETWEEN 9 BeV PROTONS AND PHOTOGRAPHIC EMULSION NUCLEI. N.P.Bogachev, S.A.Bunyatov, T.Vishki, Yu.P.Merekov, V.M.Sidorov and V.A.Yarba.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 432-40 (Feb., 1960).
In Russian.

Nuclear disintegrations produced in photographic emulsions by 9 BeV protons and producing not less than three fast particles were studied. The charged π-meson energy spectrum measured up to 540 MeV and extrapolated to the high energy region is presented. The angular distributions of fast π-mesons and protons in the laboratory coordinate system were obtained. The mean numbers of π-mesons and fast problems per disintegration were found. The fraction of primary proton energy transferred to π-mesons is estimated. The ratio of the number of π- and K-mesons in the velocity range β = 0.5-0.8 was derived.

539.17

9620 KNOCK-ON ALPHA PARTICLES PRODUCED BY FAST NUCLEONS. V.I.Ostroumov and R.A.Filov.
Zh. eksper. teor Fiz., Vol. 37, No.3(9), 643-50 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 459-64 (March, 1960).

Investigates the cross-section for the ejection of α-particles with energies > 30 MeV from photographic emulsion nuclei bombarded by 100, 140, 200, 360 and 660 MeV protons. The ejection of the particles by cascade nucleons is computed under the assumption that the intranuclear nucleons have definite momenta. It is found that there is an appreciable probability of formation of α substructures in light nuclei such as C^{12} or O^{16}, as well as in the diffuse region of heavy nuclei.

539.17

9621 RECOIL NUCLEI FROM THE DISINTEGRATION OF SILVER BY FAST PROTONS. N.I.Borisova, M.Ya.Kuznetsova, L.N.Kurchatova, V.N.Mekhedov and L.V.Chistyakov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 366-73 (Aug., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 261-6 (Feb., 1960).

The angular and energy distributions were studied of the recoil nuclei Ag^{106}, $Ag^{103+104}$, Nb^{90}, Zr^{88}, Rb^{81+82} and Se^{73} produced when silver is bombarded by 480 MeV protons. These isotopes were separated from the reaction products radiochemically. The energy distribution of the recoil nuclei is shown to be exponential, and the parameters of the distribution are determined at an angle of 90°. A qualitative explanation is given of the observed distribution. The results confirm that Se^{73}, Rb^{81+82}, Zr^{88}, and Nb^{90} are formed by evaporation of α-particles, protons, and neutrons.

539.17

9622 FRAGMENTATION OF Ag AND Br NUCLEI BY 9 BeV PROTON ENERGY. N.A.Perfilov, N.S.Ivanova, O.V.Lozhkin, M.M.Makarov, V.I.Ostroumov, Z.I.Solov'eva and V.P.Shamov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 345-50 (Feb., 1960).
In Russian.

Formation of multicharged particles with $Z \geq 4$ due to interaction of 9 BeV protons with Ag and Br nuclei in photographic emulsions was investigated. The fragment production cross-section, and the angular, energy and charge distributions of the fragments were determined. The properties of nuclear disintegrations involving formation of fragments were examined.

539.17

9623 FRAGMENTATION OF BISMUTH NUCLEI. V.F.Darovskikh, N.P.Kocherov and N.A.Perfilov.
Zh. eksper. teor, Fiz., Vol. 37, No. 5(11), 1292-5 (Nov., 1959).
In Russian.

Fragmentation of bismuth nuclei induced by 600 MeV protons was studied by imbedding small bismuth particles in a nuclear emulsion. Data were obtained on the cross-section of the process, angular distribution of the fragments (forward–backward ratio) and the charge and energy distribution of multi-charged particles.

539.17

9624 RESULTS OF A STUDY OF THE DISINTEGRATION OF CARBON NUCLEI BY 660 MeV PROTONS.
A.P.Zhdanov and P.I.Fedotov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 392-8 (Aug., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 280-4 (Feb., 1960).

The disintegration of the carbon nuclei in a suspension of diamond particles introduced into a nuclear emulsion was investigated. The cross-sections for the various reactions were obtained. An analysis of the angular and energy distributions of the disintegration was carried out under the assumption of a two-stage interaction between high-energy particles and light nuclei.

539.17

9625 ANGULAR DISTRIBUTION OF α-PARTICLES FROM THE REACTION $C^{12}(p,p'3\alpha)$.
S.S.Vasil'ev, V.V.Komarov, G.V.Koshalyaev and A.M.Popova.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1460-1 (Nov., 1959).
In Russian.

At 29 MeV, the angular distribution is peaked about 60°, which is ascribed to a direct interaction of the incoming proton with one of the alpha particles. At 22 MeV, the angular distribution is symmetric about 90° but certain individual events suggest a direct p–α interaction. D.W.L.Sprung

539.17

9626 INELASTIC SCATTERING OF NUCLEONS BY LIGHT NUCLEI. R.Kajikawa and W.Watari.
Progr. theor. Phys., Vol. 18, No. 2, 103-20 (Aug., 1957).

Inelastic scattering of nucleons by light nuclei is analysed by

adopting the direct interaction model. The interaction between an incident nucleon and the target nucleus is taken into account by using the distorted wave method. It is assumed that the two-body interaction between the incident nucleon and the nucleons which are most loosely bound to the target nucleus is the interaction which causes inelastic excitation of the target nucleus. Calculations are made for C^{12} and Mg^{24} nuclei as examples. It is shown that the results are closely dependent on the parameters involved in the calculation. Although a good fit between the calculated results and the experimental data is not intended here, some general features are compared in detail. Unknown factors which have not been taken into consideration are also discussed.

539.17

9627 ENERGY MEASUREMENTS OF PROTON RESONANCES IN LIGHT NUCLEI.

J.Kuperus, P.J.M.Smulders and P.M.Endt.
Physica, Vol. 25, No. 7, 600-9 (July, 1959).

A search has been made for (p,γ) resonances in all stable nuclides from F^{19} to S^{33} for proton energies in the 0.20-0.85 MeV range. The energies of eighty-one resonances were measured with an average precision of 0.24%. Four new resonances, at 431.0 ± 1.3, 436.9 ± 1.3, 480.1 ± 1.0, and 725.5 ± 1.2 keV, were observed in the $Ne^{22}(p,\gamma)Na^{23}$ reaction, and one new resonance, at 501.4 ± 1.4 keV, was found in the $Mg^{25}(p,\gamma)Al^{26}$ reaction.

539.17

9626 SMALL-ANGLE PROTON SCATTERING AT 3 BeV.

W.M.Preston, R.Wilson and J.C.Street.
Phys. Rev., Vol. 118, No. 2, 579-88 (April 15, 1960).

The differential cross-section for elastic scattering of 3 BeV protons was measured with targets of hydrogen, carbon, copper and lead over the angular range 0.5° to 4° in the laboratory coordinate system. Within the limits of error, no evidence was found of Coulomb–nuclear interference with hydrogen, while with carbon there is indication of a real component of the nuclear scattering amplitude associated with a repulsive force. It is inferred from the extrapolated nuclear scattering cross-section at zero degrees that appreciable scattering results from spin-dependent forces with hydrogen but not with carbon. A derived value of the r.m.s. radius for p–p scattering exceeds that found in electron–proton scattering by a factor $\sqrt{2}$.

539.17

9629 INELASTIC SCATTERING OF NUCLEONS ON Mg^{24} AND Si^{28} NUCLEI. V.I.Mamasakhlisov and T.I.Kopaleishvili.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 131-6 (July, 1959). In Russian. English translation in : Soviet Physics – JETP (New York), Vol. 37(10), No. 1, 93-7 (Jan., 1960).

This is investigated taking into account Coulomb interaction for (1) excitation of collective nuclear levels, and (2) single-particle excitation in the field of a deformed nucleus. An analysis is made of the relation between the character of the angular distribution and magnitude of the effective cross-section on the one hand, and the magnitude and the sign of the deformation on the other.

539.17

9630 (p,γ) REACTIONS ON Mg^{25} AND Mg^{26} ISOTOPES.
R.Barjon, M.Lambert and J.Schmouker.
J. Phys. Radium, Vol. 19, No. 1, 47-8 (Jan., 1958). In French.

The performance of the 2 MeV Van de Graaff belonging to "Ecole Polytechnique" is described and data on the excitation curves of Mg^{25} and Mg^{26} by protons in the 1 to 2 MeV energy range are given.

539.17

9631 (γ,γ) ANGULAR CORRELATION IN THE REACTION $N^{14}(p,\gamma)O^{15}$.
S.Gorodetzky, A.Gallmann and M.Croissiaux.
J. Phys. Radium, Vol. 19, No. 1, 16-17 (Jan., 1958). In French.

The resonance at 1060 keV in the $N^{14}(p,\gamma)O^{15}$ reaction has been investigated. Three angular correlations $\gamma-\gamma$ in the cascade 8.34 MeV–5.27 MeV–0 have been measured. The experimental results agree with the values $J = \frac{3}{2}$ or $J = \frac{5}{2}^+$ for the angular momentum of the 5.27 MeV level.

539.17

9632 TOTAL CROSS SECTIONS OF THE $O^{18}(p,\alpha)N^{15}$ AND $O^{18}(p,n)F^{18}$ REACTIONS. J.M.Blair and J.J.Leigh.
Phys. Rev., Vol. 118, No. 2, 495-8 (April 15, 1960).

The angular distribution of the α-particles from the $O^{18}(p,\alpha)N^{15}$ reaction and the total cross-section for the $O^{18}(p,n)F^{18}$ reaction were measured for proton energies between 2.60 and 2.97 MeV. Comparison of the total cross-sections for the two reactions eliminates the previously observed differences in resonance energies in these reactions. At most energies the α-particles are preferentially emitted in the forward and backward directions and the angular distributions are rapid functions of proton energy.

539.17

9633 SECONDARY NUCLEAR REACTIONS INDUCED IN TIN BY FAST PROTONS.

M.Ia.Kuznetsova, V.N.Mekhedov and V.A.Khalkin.
J. nuclear Energy, Vol. 9, No. 1-4, 240-7 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 455 (1958).

Nuclear reactions in which spallation products are captured by the target nucleus have been studied by the radiochemical method. The excitation functions of secondary reactions leading to product nuclei having charges 2 or 3 units greater than that of the target nuclei have been obtained from measurements of the yields of isotopes of tellurium (Z = 52) and iodine (Z = 53) formed in the 170-660 MeV proton bombardment of tin (Z = 50). The cross-sections of these reactions increase with increasing proton energy: for E_p = 170 MeV, $\sigma(\alpha,xn)$ and $\sigma(Li,xn)$ are 18.5 ± 5 and 0.17 ± 0.1 μbarns, respectively; for E_p = 660 MeV, these cross-sections are 50 ± 6.5 and 1.6 ± 0.5 μbarns, respectively. The cross-sections for the capture of lithium nuclei by tin obtained in this work are in good agreement with the results for similar reactions with copper, tin, and lead over a comparable proton energy interval but they are 50 times less than the cross-sections found by Marquez and Perlman (Abstr. 5747 of 1951). The observed secondary reaction cross-sections for the capture of lithium nuclei can be accounted for only by supposing that the lithium nuclei are emitted with energies greater than they could acquire as a result of fission or evaporation of the target nucleus. Secondary reactions of the type (α,xn) can be accounted for by assuming that the α-particles are emitted as a result of the evaporation process.

539.17

9634 USE OF THE (d, p) REACTION TO EXCITE STATES WITH LARGE SPINS.

B.G.Neudachin, I.B.Teplov and A.F.Tulinov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8) 548-50 (Aug., 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 37(10), No. 2, 387-9 (Feb., 1960).

It is suggested that (d, p) reactions in which a proton is directly ejected after capture of the incident deuteron may provide a useful method for the excitation of states having large spins. C.J.Batty

539.17

9635 ENERGY SPECTRA OF PROTONS FROM (d,p) REACTIONS IN HEAVY ELEMENTS.

B.L.Cohen, J.B.Mead, R.E.Price, K.S.Quisenberry and C.Martz.
Phys. Rev., Vol. 118, No. 2, 499-506 (April 15, 1960).

Surveys of proton energy distributions from (d,p) reactions were made on nuclei with Z > 30 using resolutions of 500 and 80 keV. The gross structure shows broad peaks due to the major nuclear shells, as expected from the fact that (d,p) stripping reactions excite single-particle states; peaks due to the subshell structure can be seen in some cases, especially in the heavier nuclei. The energies of the various peaks do not shift from element to element in the manner expected from simple theory; it is shown that this is not in conflict with neutron cross-section evidence, and possible explanations are proposed. The energy spacing between major shells derived from these measurements allow calculation of the reduced mass for nucleons in nuclei; the result is very different from the predictions of Brueckner theory, but explanations for this discrepancy are advanced. The results and their interpretation given here are in direct conflict with the Wilkinson theory of gamma-ray giant resonances. The energy spectra are very similar at different angles, which indicates that the stripping process is predominant at all angles. Deviations from Butler angular distribution theory at large angles must therefore be due to difficulties in that theory rather than due to the onset of competing process.

539.17

9636 ON THE EXCHANGE EFFECT IN THE STRIPPING REACTIONS. T.Kammuri, R.Naksima and S.Takgi.
Progr. theor. Phys., Vol. 17, No. 2, 306-7 (Feb., 1957).

The reaction matrix element for the (d,n) reaction is formulated

in general terms for the case of heavy particle stripping, in which exchange of neutron (l) in the deuteron with a neutron (say k) from the outmost orbit of the target nucleus, occurs. It is then particularized to the special case of a single neutron in the outmost orbit. For the calculation of this matrix element the interactions between the neutron (l) and the target nucleus, and between the neutron (k) and the deuteron, are neglected. The deuteron wave function is replaced by the zero-range wave function whilst that of the neutron (k) is taken as that for a single particle moving in a suitable square well potential. The angular distribution calculated on this basis for the $C^{13}(d,n)N^{14}$ reaction with E_d = 0.865 MeV compares well with the experimental results obtained by other workers. It is concluded that the present single particle treatment is a good approximation to the compound nucleux process in the reaction $C^{13}(d,n)N^{14}$. A.E.I.Research Laboratory

539.17

9637 PROTON ANGULAR DISTRIBUTIONS IN THE REACTION $Mg^{24}(d,p)Mg^{25}$.
G.R.Bishop, P.Demay and F.Demichelis.
J. Phys. Radium, Vol. 19, No. 1, 46 (Jan., 1958). In French.

The angular distributions of the proton groups resulting from the reaction $Mg^{24}(d,p)Mg^{25}$ have been measured for bombarding energies between 1 and 2 MeV. The results show that both stripping and compound nucleus formation contribute to the reaction. Formation of the compound nucleus Al^{26} is confirmed by an excitation curve which shows distinct resonances.

539.17

9638 THE (d,t) REACTION ON C^{12}, F^{19} AND Al^{27} NUCLEI.
N.A.Vlasov, S.P.Kalinin, A.A.Ogloblin, V.I.Chuev.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1187-92 (Nov., 1959). In Russian.

The spectra and angular distributions of tritons produced in the reactions $C^{12}(d,t)C^{11}$, $F^{19}(d,t)F^{18}$ and $Al^{27}(d,t)Al^{26}$ for 20 MeV deuterons were measured using the β-radioactivity of tritium. The spins and parities of a number of states of F^{18} and Al^{26} were derived by comparing the triton angular distributions obtained with Butler's theory. The probability of excitation of levels of the residual nucleus sharply drops with increase of their energy.

539.17

9639 THE (d,t) REACTIONS IN MEDIUM AND HEAVY NUCLEI.
N.A.Vlasov, S.P.Kalinin, A.A.Ogloblin and V.I.Chuev.
Zh. eksper. teor, Fiz., Vol. 38, No. 1, 280-2 (Jan., 1960). In Russian.

The triton spectra of the (d,t) reactions in Fe, Zr, In, Au, and Bi were measured. The deuterons were accelerated in a cyclotron to an energy of 20 MeV, and the spectra determined from the activity of tritium in the target foil. The results are presented graphically. H.C.Cole

539.17

9640 (d, t) REACTIONS ON Li^6, Li^7 AND Be^9 NUCLEI.
N.A.Vlasov and A.A.Ogloblin.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 54-61 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 39-44 (Jan., 1960).

The spectra of tritons emitted at various angles in these reactions were studied for 20 MeV deuterons. The probability of formation of excited states in the final nucleus decreases sharply with increasing excitation energy. Angular distributions were obtained for triton groups corresponding to the formation of Li^5 in the ground state, Li^6 in the ground and in the first two excited states, and Be^9 in the ground and in the first excited state. The angular distributions are in good agreement with those computed from the Butler formula for (d, t) reactions, but the radius increases with the level energy

539.17

9641 THE ELASTIC SCATTERING OF ^3He BY MEDIUM WEIGHT NUCLEI. G.W.Greenlees and P.C.Rowe.
Nuclear Phys., Vol. 15, No. 4, 687-93 (March (2), 1960).

Absolute differential cross-sections were measured for the elastic scattering of He^3 from Ni, Pd, Cd, Sn, Au. Energy distributions for Ni, Cd and Au in the region 30-18 MeV and angular distributions for Ni, Pd, Cd, Sn in the range 15°-60° (c.m.s.) were found. The results show that an approximately exponential fall-off in cross-section occurs in both the energy and angular variations. Interaction radii were derived from the experimental curves by using the sharp cut-off theory of Blair (Abstr. 10488 of 1954). By comparison with recent alpha-particle results the difference in the He^3 and He^4 interaction radii was found to be $(0.11 \pm 0.01) \times 10^{-12}$ cm.

539.17

9642 AN INVESTIGATION OF THE $Si^{30}(He^3,d)P^{29}$ AND $Si^{30}(He^3,\alpha)Si^{27}$ REACTIONS AT A BOMBARDING ENERGY OF 9.16 MeV. S.Hinds and R.Middleton.
Proc. Phys. Soc., Vol. 75, Pt 3, 444-7 (March, 1960).

The angular distribution of the deuteron and α-particle groups was measured and an attempt made to fit these with curves calculated on the basis of a direct reaction process. C.J.Batty

539.17

9643 EXCITATION OF ROTATIONAL STATES OF NON-AXIAL NUCLEI IN α-PARTICLE SCATTERING.
E.A.Romanovskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 851-3 (Sept., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 3, 606-7 (March, 1960).

The probability of exciting the second 2+ level in even-even non-axial nuclei by α-particles with energy greater than the height of the Coulomb barrier is estimated. It is shown that for Cd^{114} the cross-section is approximately an order of magnitude less than that for elastic scattering. C.J.Batty

539.17

9644 INVESTIGATION OF THE (α,α'), (α,p) AND (α,t) REACTIONS ON LITHIUM NUCLEI.
K.V.Makaryunas and S.V.Starodubtsev.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 372-8 (Feb., 1960). In Russian.

The angular distribution of the reaction $Li^7(\alpha,\alpha')Li^{7*}$ (Q = −4.61 MeV) was investigated for the bombarding α-particle energy E_α = 13.2 MeV and also the angular distributions of the reactions $Li^7(\alpha,t)Be^8$ (Q = −2.56 MeV), $Li^6(\alpha,p)Be^9$ (Q = −2.13 MeV) and $Li^7(\alpha,p)Be^{10}$ (Q = − 2.56 MeV) for E_α = 10.15, 11.5 and 13.2 MeV. The results can be explained by direct interaction theories. From an interpretation of the experimental angular distribution of the reaction (α,α') within the framework of Butler's theory it follows that the parity of the 4.61 MeV level in the Li^7 nucleus is negative and the spin is equal to one of the following four values: $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$.

539.17

9645 ELASTIC SCATTERING OF ALPHA PARTICLES BY O^{16}.
L.C.McDermott, K.W.Jones, H.Smotrich and R.E.Benenson.
Phys. Rev., Vol. 118, No. 1, 175-81 (April 1, 1960).

Absolute cross-sections for the elastic scattering of alpha particles by O^{16} were measured in a differentially pumped gas scattering chamber. The measurements were made for laboratory energies from 3.7 to 6.5 MeV, corresponding to 7.7 to 9.9 MeV excitation in Ne^{20}, at centre-of-mass angles of 168.9°, 149.4°, 140.8°, 125.3° and 90.0°. Narrow resonances were observed at bombarding energies of 5.002, 5.11, 5.190, 5.432, 5.532 and 6.030 MeV. The data were analysed in terms of Wigner–Eisenbud dispersion theory to find the spins, parities, resonant energies, widths, reduced widths, and characteristic energies of the levels. The resonances observed correspond to states in Ne^{20} with the following excitation energies, spins, and parities: 8.755(1−), 8.84(5−), 8.905(1−), 9.099(4+), 9.179(3−), and 9.577 MeV (2+). In order to obtain a good fit to the data, it was necessary to assume the existence of two broad overlapping resonances, one at ~8.7 MeV excitation (0+) and the other at ~8.8 MeV (2+). There is also some evidence for the presence of a broad 4+ level at an energy higher than 9.9 MeV excitation in Ne^{20}.

539.17

9646 (αt) REACTIONS NEAR Z = 28.
J.L.Yntema.
Phys. Rev. Letters, Vol. 4, No. 6, 297-9 (March 15, 1960).

The spectra of tritons from (α,t) reactions with Mn^{55}, Co^{59}, Cu^{63}, Rh^{103} and Ta^{181} were examined, using 43 MeV α-particles. Resonances were observed corresponding to excited and ground states of product nuclei. The distribution of these, and especially the complete absence of ground-state Fe^{56} from the Mn^{55} reaction, suggests very strongly stripping reactions. Some preliminary angular-distribution measurements support this conclusion. J.H.Fremlin

539.17

9647 NEUTRON PRODUCTION BY HEAVY-ION BOMBARDMENTS.

E.L.Hubbard, R.M.Main and R.V.Pyle.

Phys. Rev., Vol. 118, No. 2, 507-14 (April 15, 1960).

Neutron yields from C^{12}, N^{14}, and Ne^{20} bombardments of a number of target elements were measured by an activation method. The maximum bombarding energies were 10.4 MeV per nucleon of the incident ion. Neutron yields were calculated by assuming complete fusion of the two nuclei, with an interaction radius of $r_0 \approx 1.5 \times 10^{-13}$ cm, followed by de-excitation of the compound nuclei by neutron emission only. Calculated neutron yields are a factor of about two higher than experiment in the case of heavy target nuclei, with greater differences for light targets. Some possible refinements of the theory that could bring the results closer to agreement with experiment are mentioned.

539.17

9648 RESONANT ELASTIC SCATTERING OF C^{12} BY CARBON. D.A.Bromley, J.A.Kuehner and E.Almqvist.

Phys. Rev. Letters, Vol. 4, No. 7, 365-7 (April 1, 1960).

Elastic scattering of C^{12} by carbon and of O^{16} by oxygen was examined with high energy-resolution in the range of laboratory energies 6-29 MeV. Excitation curves show a simple steady fall from the Coulomb cross-section for the O case above the potential barrier, but the C case shows a smaller drop with a series of sharp resonances. Angular distributions show a rapid change with particle energy. Possible mechanisms for production of resonances are discussed, the preferred one involving the formation of high-spin states of Mg^{24} with half-lives of order 10^{-21} sec. J.H.Fremlin

539.17

9649 PRODUCTION CROSS-SECTION OF Fm^{250} IN THE REACTIONS $Pu^{241}(C^{13}, 4n)Fm^{250}$ AND $U^{238}(O^{16},4n)Fm^{250}$. V.V.Volkov, L.I.Guseva, B.F.Myasoedov, N.I.Tarantin and K.V.Filippova.

Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1207-11 (Nov., 1959). In Russian.

The cross-section for production for Fm^{250} in the reactions $Pu^{241}(C^{13}, 4n)$ and $U^{238}(O^{16},4n)$ was determined as a function of the bombarding particles. Comparison of the cross-section for production of Fm^{250} with the fission cross-section in these reactions shows that in the overwhelming majority of cases the excited compound nucleus Fm^{254} undergoes fission, and only in a very few cases de-excitation takes place as a result of neutron emission. The maximal cross-sections for production of Fm^{250} by irradiation with oxygen or carbon ions are respectively 1×10^{-30} cm^2 and 5×10^{-30} cm^2. The difference between these cross-sections is probably due to the effect of the Coulomb barrier.

539.17

9650 PRODUCTION OF COMPOUND NUCLEI BY BOMBARDMENT OF V AND Nb WITH O^{16}, C^{12}, AND C^{13} IONS.

A.S.Karamyan and A.A.Pleve.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 654-62 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 467-73 (March, 1960).

The production of compound nuclei in the reactions $V^{51} + O^{16} \rightarrow Ga^{67}$ and $Nb^{93} + C^{12,13} \rightarrow Ag^{105,106}$ was investigated. The results are given in the form of excitation functions for the evaporation of different numbers of nucleons. Comparison of these reactions with reactions induced by light particles and involving compound nuclei close to Ga^{67} and Ag^{105} shows that in the case of heavy ions evaporation of a specified number of nucleons occurs at a somewhat higher excitation energy. A possible explanation is that the large angular momentum which the heavy ion contributes to the compound nucleus significantly affects the de-excitation process. Along with the production of a compound nucleus and subsequent evaporation of nucleons, reactions were observed in which very energetic particles were emitted (60 MeV with two particles). This is not consistent with the statistical theory.

539.17

9651 SCATTERING OF ELECTRONS BY LIGHT NONSPHERICAL NUCLEI. E.V.Inopin and B.I.Tishchenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1308-18 (Nov., 1959). In Russian.

Scattering of electrons on nonspherical nuclei is treated in the Born approximation. Expressions for the elastic and inelastic scattering cross-sections are derived in the general case of oriented nuclei possessing arbitrary deformations. The theory is compared with experiments on inelastic scattering of electrons by light nuclei.

539.17

9652 SCATTERING OF ELECTRONS AND POSITRONS BY XENON AND MERCURY.

J.R.Atkinson, J.R.Greer and G.Wyllie.

Proc. Phys. Soc., Vol. 75, Pt 3, 447-9 (March, 1960).

The scattering of electrons and positrons of about 1 MeV energy was measured and found to be in good agreement with theoretical predictions. Possible reasons for anomalies found in previous experiments are discussed. C.J.Batty

539.17

9653 OPTICAL ANISOTROPY OF ATOMIC NUCLEI. A.M.Baldin.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7) 202-11 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 142-8 (Jan., 1960).

The concepts of molecular optics are extended to photonuclear reactions. The consequences of the existence of the tensor polarizability of nuclei, not yet discovered experimentally, are discussed. Various models of tensor polarizability are examined and estimates are given for the magnitudes of the effects that could be observed with present experimental capabilities.

539.17

9654 ONE-PARTICLE MECHANISM IN [HIGH-ENERGY] PHOTONUCLEAR REACTIONS. G.M.Shklyarevskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1492-6 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1057-60 (Nov., 1959).

Investigated on the basis of the shell model. It is shown that the ground state momentum distribution obtained from that model allows one to explain the forward shift of the maximum in the angular distribution of the photoprotons and leads to a correct magnitude of the reaction cross-section.

539.17

9655 RESONANCE SCATTERING OF LOW-ENERGY GAMMA RAYS ON NUCLEI. B.N.Kalinkin.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1438-42 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1022-4 (Nov., 1959).

The mechanism of this scattering is discussed, and it is shown that it is of the nature of nuclear resonance fluorescence and that excitation of the nucleus can be described by means of one-nucleon transitions. The gamma-ray scattering cross-section is calculated on the basis of the shell theory. Excited level widths are estimated from the Fermi gas model and the results obtained by Signell and Marshak (Abstr. 2468 of 1958) in connection with the theory of nucleon scattering. The results are in satisfactory agreement with the experimental data.

539.17 : 539.14

ENERGY LEVEL PARAMETERS FROM NUCLEAR RESONANCE FLUORESCENCE AT 7 MeV. See Abstr. 9526

539.17

9656 ELASTIC SCATTERING OF 1.12, 1.17, 1.33 AND 2.62 MeV γ-RAYS.

J.Banaigs, P.Eberhard, L.Goldzahl and E.Hara.

J. Phys. Radium, Vol. 19, No. 1, 70-2 (Jan., 1958). In French.

A comparison is made of experimental and theoretical results to demonstrate the Delbruck effect. The conclusion was negative for 1.12 and 1.33 MeV, but it was difficult to draw a conclusion for 2.62 MeV. For 1.17 MeV, a possible intervention of the inelastic scattering has been found.

539.17

9657 SPECTRUM OF PHOTO-PROTONS PRODUCED BY GAMMA RAYS IN THE NARROW 82-89 MeV ENERGY RANGE. E.B.Bazhanov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 374-9 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 267-70 (Feb., 1960).

Energy spectra were investigated for protons ejected from C^{12} and Al^{27} by γ-rays from bremsstrahlung spectra possessing peak energies of 82 and 89 MeV. The experimental data are compared

with curves based on Dedrick's data (Abstr. 664 of 1956). Although the agreement is not very good it may nevertheless be possible that the quasi-deuteron mechanism contributes significantly to the interaction of γ-rays with the nuclei considered.

539.17

9658 THEORY OF THE DIRECT NUCLEAR PHOTO-EFFECT. Yu.V.Orlov.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1834-6 (Dec., 1959). In Russian.

The (γ,n) cross-section for C^{12} was calculated at 3, 5, and 10 MeV, treating the nucleus as a square well and neglecting spin–orbit interaction. Inclusion of the imaginary part of the optical model potential in the final state diminishes the cross-sections considerably and alters their shape. D.W.L.Sprung

539.17 : 539.14

RESONANCE SCATTERING OF GAMMA-QUANTA ON Cd^{114} NUCLEI. See Abstr. 9597

539.17

9659 PHOTODISINTEGRATION OF Li^6. D.G.Proctor and W.H.Voelker.
Phys. Rev., Vol. 118, No. 1, 217-21 (April 1, 1960).

The photodisintegration of Li^6 by bremsstrahlung radiation of 17.3 MeV peak energy was investigated by use of coincidence techniques to detect neutron–proton coincidences and by measurement of the photoproton energy spectra. The $Li^6(\gamma,n)Li^5$ reaction is found to be responsible for 0.58 ± 0.13 of the photoneutron yield measured by Romanowski (Abstr. 6124 of 1959) while the $Li^6(\gamma,p)He^5$ reaction contributes 0.31 ± 0.04 of the yield. No angularly correlated neutron–proton coincidences were detected which would support a deuteron–alpha-particle model for the $Li^6(\gamma,np)He^4$ reaction; however, the possible existence of this reaction is not eliminated.

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9660 PHOTONEUTRON CROSS SECTIONS OF Li, N, AND A. R.W.Fast, P.A.Flournoy, R.S.Tickle and W.D.Whitehead.
Phys. Rev., Vol. 118, No. 2, 535-9 (April 15, 1960).

Using a Halpern-type photoneutron detection system (Abstr. 1947 of 1953) the photoneutron yields from Li, N^{14}, and A^{40} were measured as a function of the maximum bremsstrahlung energy from threshold to approximately 50 MeV. The method of Penfold and Leiss was used to extract from the yield curves the total neutron cross-section:

$$\sigma_T = \sigma(\gamma,n) + \sigma(\gamma,pn) + 2\sigma(\gamma,2n) + \cdots .$$

The results are compared with previous findings of other laboratories. No gross structure was detected in the lithium cross-section in the giant resonance region. The data indicate that lithium has a high-energy tail on the cross-section of considerable magnitude.

539.17

9661 RESONANCE SCATTERING OF GAMMA QUANTA BY Mg^{24}. I.Sh.Vashakidze, T.I.Kopaleishvili and G.A.Chilashvili.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 750-5 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 535-8 (March, 1960).

Investigates resonance scattering with excitation of the first two levels of the nuclei at 1.37 and 4.23 MeV. Analysis of the correlation formula enables one to draw conclusions concerning the character of the excitation of the nucleus.

539.17

9662 RESONANT SCATTERING OF 23.8 keV γ-RAYS EMITTED WITHOUT RECOIL FROM Sn^{119}. R.Barloutaud, J.L.Picou and C.Tzara.
C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2705-7 (April, 1960). In French.

Protons re-emitted by Sn^{119} after resonant absorption of γ-rays from non-recoiling Sn^{119} nuclei have been observed and the Debye–Waller factor at about 90° K measured. This was found to be in good agreement with results from transmission measurements. S.E.Hunt

539.17

9663 THE SMALL-ANGLE SCATTERING OF PHOTONS OF ABOUT 100 MeV ENERGY. J.Moffatt and M.W.Stringfellow.
Proc. Roy. Soc. A, Vol. 254, 242-58 (Feb. 9, 1960).

Differential cross-sections were measured for the scattering of photons of mean energy 87 MeV by uranium at eight angles in the range from 1.16 to 4.46 mrad and by aluminium, silver, tungsten, lead and uranium at angles of 1.89 and 4.24 mrad, using a narrowly collimated bremsstrahlung beam from the Oxford 110 MeV synchrotron as the primary source of photons. A biased total-absorption Cherenkov counter was used to detect photons with energies near the peak energy of the bremsstrahlung spectrum, and absolute differential cross-sections were measured by comparing counting rates for photons in the primary and scattered beams. The experimental results, with the differential Compton scattering cross-sections of Klein and Nishina subtracted, were analysed in terms of their variation with angle and atomic number, and can be described as consisting of a sharply peaked angular distribution with absolute cross-sections varying from element to element as Z^4, together with a uniform distribution varying nearly as Z^2; these distributions were identified with Delbrück scattering and with bremsstrahlung from secondary electrons in the scattering target, respectively. The Delbrück scattering cross-section thus determined is slightly more sharply peaked than the cross-section predicted by an approximate theory of Bethe and Rohrlich (Abstr. 4580 of 1952).

539.17

9664 CLOUDY CRYSTAL BALL MODEL FOR NEUTRON REACTIONS AT HIGHER ENERGIES. M.Kawai, M.Nagasaki, M.Soga, T.Terasawa, H.Ui and Y.Wada.
Progr. theor. Phys., Vol. 18, No. 1, 66-80 (July, 1957).

A systematic analysis using the cloudy crystal ball model (Abstr. 524 of 1955) was carried out for the total cross-sections and the non-elastic cross-sections of neutron scattering by nuclei, in the energy range 3.5 to 14.0 MeV. Almost all regions of the mass number of the target nuclei were covered except for very light ones. The optical potentials assumed use of the square well shape. The energy dependence of the potential strength, V + iW, and the mass number dependence of the range of potential, R, were studied. It is found that the mass number dependence of the total cross-sections at each of the fixed energies is repreduced by the calculation with a suitable choice of potential parameters. The calculation fails to give the correct magnitude of the non-elastic cross-sections. The calculated values are considerably smaller then the experimental ones especially for lower incident energies. The parameters which were found to give the best fit to the experimental data are as follows: $R = (0.5 + 1.35\,A^{1/3}) \times 10^{-13}$ cm; V = 40 MeV for all the neutron energies studied; W varies from 2 to 7 MeV as the incident energy increases from 3.5 to 14.0 MeV.

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9665 MULTIPLE-SCATTERING CORRECTIONS IN "SPHERICAL" AND "RING" GEOMETRY. V.F.Turchin.
J. nuclear Energy, Vol. 9, No. 1-4, 169-77 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 244 (1958).

A method is given for making a correction for multiple scattering in experiments to measure the angular distribution of elastically scattered neutrons, when the average path length of the neutron in the specimen is comparable with, but not substantially greater than, the scattering mean free path. In the case of isotropic nuclear scattering the probabilities of multiple scattering are evaluated for a sphere and for ring specimens of circular and rectangular cross-section; double scattering by direct reduction of the appropriate integrals and higher order processes by approximate methods. The anisotropic scattering of neutrons of several MeV is dealt with by representing the cross-section $\sigma(\theta) = \sigma_1(\theta) + \sigma_2(\theta)$ as the sum of $\sigma_1(\theta)$, a forward peak, and $\sigma_2(\theta)$ a more or less isotropic remainder term. Nuclear scattering events are then divided into two types according as to which partial cross-section is involved, and double-scattering processes correspondingly divided into four classes. The probabilities of all the four last-mentioned classes are calculated from the results of the theory for isotropic scattering. Higher multiplicities of scattering are treated in the same way.

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9666 SOME NEUTRON RESONANCE-ABSORPTION INTEGRALS. V.B.Klimentov and V.M.Griazev.
J nuclear Energy, Vol. 9, No. 1-4, 20-7 (June, 1959). English translation of article in : Atomnaya Energiya, Vol. 3, 507 (1957).

Observed resonance absorption integrals are reported for 42 elements, ten of which have not been examined hitherto. The method involves an accurate measurement of the reactivity of a reactor when the specimen is inserted into the core, and gives the resonance absorption integral for the epicadmium spectrum of the reactor.

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9667 NONELASTIC SCATTERING OF FAST NEUTRONS.
J.T.Prud'homme, P.L.Okhuysen and I.L.Morgan.
Phys. Rev., Vol. 118, No. 4, 1059-62 (May 15, 1960).

The relative angular distributions of neutrons inelastically scattered from iron, yttrium, zirconium, radiogenic lead (88% Pb^{208}), lead, and bismuth were measured for neutrons in the region from 3.7 to 4.7 MeV. The relative angular distributions of the low-energy (0.5 to 4 MeV) neutrons resulting from nonelastic scattering of 15.2-MeV neutrons were also measured. In each case the distributions were found to be isotropic within experimental error (±15%), therefore supporting earlier evidence of compound nucleus formation as the predominant interaction mechanism.

539.17

9668 INELASTIC SCATTERING OF FAST NEUTRONS.
K.Winter.
Cashiers de Phys., Vol. 12, 376-82 (Oct., 1958). In French.

The assumptions of the statistical model are discussed, and its implications compared with experimental energy spectra and angular distributions of inelastically scattered 14 MeV neutrons, allowing for the perturbing effect of the (n, 2n) reaction above its threshold. Although most of the cross-section is accounted for by compound nucleus formation, an admixture of direct interaction is apparent.
A.E.I. Research Laboratory

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THE (n,γ) CAPTURE OF THERMAL NEUTRONS. See Abstr. 9592

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9669 CALCULATION OF THE DIRECT INTERACTION IN THE REACTION $Be^9(n,2n)Be^8$.
R.L.Balian and V.P.Gillet
J. Phys. Radium, Vol. 19, No. 1, 10 (Jan., 1958). In French.

Cross-sections are calculated for the knock-out process of the weakly-bound neutron of Be^9 by neutrons of 0-10 MeV, both particles being in the average potential of the nucleus.

539.17

9670 ELASTIC SCATTERING OF 5.6-MeV NEUTRONS FROM CARBON. J.E.Braley and C.W.Cook.
Phys. Rev., Vol. 118, No. 3, 803-11 (May 1, 1960).

Energetic neutrons produced from the $D(d,n)He^3$ reaction were scattered from a cylindrical carbon sample to study the angular distribution of elastically-scattered 5.6-MeV neutrons. The differential elastic scattering cross-sections for carbon were obtained for angles in the range 30° to 150°. A thin plastic neutron–proton recoil detector was used in the measurements to permit discrimination against 4.4-MeV gamma rays from the carbon sample, and other gamma-ray backgrounds.

539.17

9671 THE MEASUREMENT OF SEVERAL SOFT γ-RAY LINES IN THE NEUTRON CAPTURE BY EUROPIUM, BY MEANS OF A CRYSTAL SPECTROMETER. O.Schult.
Z. Phys., Vol. 158, No. 4, 444-70 (1960). In German.

A bent-crystal X-ray spectrometer used for measurement of γ-rays with energies between 30 and 300 keV, in conjunction with a reactor, is described. The quartz crystal with the cleavage plane perpendicular to the (101) plane has a radius of 465 cm and an aperture of 1.2 × 2 cm^2. Using this instrument, the following strong γ lines (keV, ±0.005%) have been observed in neutron capture reactions of europium : 89.851; 77.259; 73.427; 72.520; 71.032; 68.171; 52.871; 51.977; 46.1517; 32.6346. S.J.St-Lorant

539.17 : 539.16

9672 ACTIVATION CROSS SECTIONS FOR 14.8 MeV NEUTRONS AND SOME NEW RADIOACTIVE NUCLIDES IN THE RARE EARTH REGION. R.G.Wille and R.W.Fink.
Phys. Rev., Vol. 118, No. 1, 242-8 (April 1, 1960).

For previous work, see Abstr. 5067 of 1959. Activation cross-sections on 27 stable nuclides of elements Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er, Yb, and Lu were measured for 14.8 ± 0.8 MeV neutrons. Highly enriched isotopes were used as targets in most cases, and in a few instances radiochemical separations were performed whenever it was necessary and possible in view of the product half-lives. The measured cross-sections for (n,2n) reactions were found to ageee within an order of magnitude with predictions from statistical evaporation theory. However, experimental values of (n,p) and (n,α) cross-sections generally appear to be larger than calculated from continuum theory of the compound nucleus. The cross-sections show no significant effects due to the 82 neutron closed shell, and furthermore, the Levkovskii effect, which is quite striking in the low Z region, appears to be negligible for (n,p) and (n,α) reactions in the rare earth region. The (n,2n) cross-sections show little variation with mass number at constant Z, and they exhibit a decrease with increasing mass number at N = 82. Several previously unreported activities were observed; their half-lives, assignment, and gamma radiations are as follows: 12 ± 3 min Pr^{143} from the Nd^{143} (n,p) reaction; 0.5 ± 0.1 min Sm^{157} from the $Gd^{159}(n,\alpha)$ reaction, 0.57 ± 0.01 MeV gamma; 7 ± 1 min Tb^{163} from the $Dy^{163}(n,p)$ reaction, 0.18 ± 0.05 MeV gamma; 3.3 ± 0.5 min Ho^{169} from the $Er^{169}(n,p)$ reaction, 0.85 ± 0.05 MeV gamma; 40 ± 10 sec Ho^{170} from the $Er^{170}(n,p)$ reaction; 4.4 ± 0.4 min Dy^{167} from the $Er^{170}(n,\alpha)$ reaction; 2.0 ± 0.5 min activity with gammas at 0.18 ± 0.01, 0.25 ± 0.01, and 0.36 ± 0.01 MeV which may be Tm^{170}, Er^{173}, or possibly isomeric Yb^{177m} from enriched Yb^{176} bombardments. Tentative assignment of a 5.5 ± 0.5 min activity to Tm^{170} is suggested from bombardment of enriched Yb^{176}.

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9673 THERMAL-NEUTRON CAPTURE GAMMA-RAYS FROM SOME RARE-EARTH ELEMENTS.
V.V.Sklyarevskii, E.P.Stepanov and B.A.Obinyakov.
J. nuclear Energy, Vol. 9, No. 1-4, 69-74 (June, 1959). English translation of article in: Atomnaya Energiya, Vol 4, 22 (1958).

Capture γ-ray spectra have been measured using a scintillation spectrometer. Strong lines were observed below 300 keV with Eu, Gd, Dy, Ho, Er, Tm, Hf and Ta. In the spectra of Er^{169} and Hf^{179}, lines of intensity 0.5-0.8 quanta per capture have been attributed to transitions of the type $4^+ \rightarrow 2^+$ and $2^+ \rightarrow 0^+$ between rotational levels.

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9674 NEUTRON-CAPTURE GAMMA-RAY SPECTRA FROM EVEN-EVEN EXCITED NUCLEI WITH ROTATIONAL LEVELS.
L.V.Groshev, A.M.Demidov, V.N.Lutsenko and V.I.Pelekhov.
J. nuclear Energy, Vol. 9, No. 1-4, 50-68 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 5(1958).

Thermal-neutron capture γ-ray spectra from Gd, Er, Hf, Dy and Ta have been measured over the range 0.3-9 MeV by use of a magnetic Compton-electron spectrometer. With the first three of these elements, the excited nuclei are Gd^{158}, Gd^{156}, Er^{169} and Hf^{179} which have rotational levels near the ground state; in their spectra a closely spaced group of intense lines is found near 1 MeV that is absent from the spectra of even-odd (e.g. Dy^{163}) and odd-odd (e.g. Ta^{180}) emitters. The properties of these lines are related to those of the low-lying levels.

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9675 THE ANGULAR DISTRIBUTIONS OF ELASTICALLY AND INELASTICALLY SCATTERED 2.9 MeV NEUTRONS.
V.I.Popov.
J. nuclear Energy, Vol. 9, No. 1-4, 9-19 (June, 1959). English translation of article in : Atomnaya Energiya, Vol. 3, 498 (1957).

The angular distributions resulting from the elastic and inelastic scattering of 2.9 MeV neutrons by iron, copper, lead and bismuth have been measured with a hydrogen-filled chamber, using "ring" geometry. Total elastic and inelastic cross-sections and the transport cross-section are given. The observations for iron and copper show that angular distribution for elastic scattering are not necessarily similar for elements of nearly the same A, but can differ markedly. The results are compared with calculations based on the optical model.

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9676 TOTAL NEUTRON CROSS SECTIONS OF HELIUM, NEON, ARGON, KRYPTON, AND XENON.
F.J.Vaughn, W.L.Imhof, R.G.Johnson and M.Walt.
Phys. Rev., Vol. 118, No. 3, 683-6 (May 1, 1960).

The total neutron cross-sections of these gases were measured for neutron energies from 120 keV to 6.1 MeV and from 12.1 to 19.8 MeV by a transmission experiment. The neutrons were produced using the $Li^7(p,n)Be^7$, $T(p,n)He^3$, $D(d,n)He^3$, and $T(d,n)He^4$ reactions in the appropriate energy intervals. A Van de Graaff accelerator was the source of the protons or deuterons. In general, the results obtained agree with previous work where such work exists. A previously unobserved S-wave scattering resonance was found in neon at about 500 keV, indicating the presence of an excited state in

Ne^{21} with $J = \frac{1}{2}$ and even parity. The results for argon, krypton, and xenon exhibit general agreement with the cross-sections of neighbouring elements, as would be expected from the previously observed smooth variations of the $\sigma(A,E)$ surface.

539.17

9677 ASYMMETRY IN THE ANGULAR DISTRIBUTION OF 1-5 MeV INELASTICALLY SCATTERED NEUTRONS.
D.Szteinsznaider, M.Roclawski-Conjeaud, V.Naggir and G.C.Phillips.
J. Phys. Radium, Vol. 19, No. 1, 54-5 (Jan., 1958). In French.

The inelastic scattering of neutrons at energy of a few MeV by I^{127} is asymmetric about 90°. This asymmetry and its slow variation with incident energy is interpreted as a process of direct interaction.

539.17

9678 SPIN STATES ASSOCIATED WITH NEUTRON RESONANCES IN In^{115}. A Stolovy.
Phys. Rev., Vol. 118, No. 1, 211-16 (April 1, 1960).

By polarizing both the neutron beam and the nuclear sample, the spin states of the first three slow neutron resonances in the target nucleus In^{115} were measured. These were obtained by observing the direction of change in the transmitted intensity upon reversing the polarization of the neutrons with respect to the target nuclei. The spin states associated with the resonances at 1.46, 3.86, and 9.10 eV were found to be J = 5, 4, and 5, respectively. These spin assignments are consistent with measurements of other parameters of these resonances.

539.17

9679 GAMMA-RAY SPECTRA EXCITED BY THE INELASTIC SCATTERING OF FAST NEUTRONS BY Mg, Al, Fe, Cu, Sn, AND Sb. I.F.Barchuk, M.V.Pasechnik and Iu.A.Tsibul'ko.
J. nuclear Energy, Vol. 9, No. 1-4, 120-7 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 132 (1958).

The study of the inelastic scattering of fast neutrons is of considerable theoretical and practical importance. From the theoretical point of view such studies provide information about the levels of stable nuclei. The practical value of these studies is due to the importance of inelastically scattered neutrons in the operation of fast neutron reactors. A knowledge of the spectra of the inelastically scattered neutrons is essential to the provision of a sound theory of fast reactors. Measurements of the spectra of gamma-rays excited by the inelastic scattering of 2.8 MeV neutrons by Mg, Al, Fe, Cu, Sn, and Sb, are reported. A NaI(Tl) scintillation spectrometer was used in this work in conjunction with a photomultiplier, and a 50 channel pulse-height analyser incorporating a magnetic drum memory device. For Co^{60} gamma-rays, the resolution of the spectrometer was 6.5-7 per cent. Gamma-rays having the following energies (MeV) were observed: Mg 0.97; 1.41; 1.92; 2.3. Al 0.84; 1.00; 1.80; 2.16. Fe 0.84; 1.25; 1.46; 1.70. Cu 0.63; 0.78; 0.96; 1.12; 1.38; 1.46; 1.72; 2.03. Sn 0.84; 1.16; 1.50; 1.80; 2.16. Sb 1.04; 1.50; 1.84; 2.16.

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9680 CROSS SECTIONS FOR THE (n,2n) REACTION IN N^{14}, P^{31}, Cu^{63}, AND Pr^{141}.
J.M.Ferguson and W.E.Thompson.
Phys. Rev., Vol. 118, No. 1, 228-32 (April 1, 1960).

The (n,2n) cross-sections were measured for neutron energies from 12.5 to 18 MeV. The annihilation radiation emitted from the product nuclides was counted with two NaI(Tl) crystals in coincidence. In the energy range measured, the cross-sections were found to vary, as follows: N^{14}, 3.03 to 11.67 mb; P^{31}, 0 to 74 mb; Cu^{63}, 186 to 836 mb; Pr^{141}, 1231 to 1737 mb. The results are generally in agreement with those of others. The data are compared with curves plotted from Weisskopf's theoretical expression for (n,2n) cross-sections (Abstr. 1507 of 1940).

539.17

9681 DIFFERENTIAL CROSS SECTIONS FOR NEUTRON RESONANCE SCATTERING FROM Na^{23}.
R.O.Lane and J.E.Monahan.
Phys. Rev., Vol. 118, No. 2, 533-5 (April 15, 1960).

The differential scattering cross-section was measured with an energy spread of ~ 25 keV for neutron energies between 200 and 800 keV. The data are presented in the form of Legendre polynomial coefficients. See also Abstr. 9534 of 1960.

539.17

9682 THE ANGULAR AND ENERGY DISTRIBUTION OF PROTONS FROM Ni^{58} REACTIONS INDUCED BY 14.8 MeV NEUTRONS. I.Kumabe and R.W.Fink.
Nuclear Phys., Vol. 15, No. 2, 316-25 (Feb. (2), 1960).

The angular and energy distributions of protons from the $Ni^{58}(n,p)Co^{58}$ and $Ni^{58}(n,np)Co^{57}$ reactions with 14.8 MeV neutrons were measured using a shielded multiplate camera. The results indicate that the $Ni^{58}(n,p)$ and $Ni^{58}(n,np)$ reactions occur predominantly through the formation and decay of the compound nucleus, with a small contribution from the direct interaction of the incident neutrons with protons. A semilog plot of the relative level densities calculated from the energy distribution of the protons fits two straight lines corresponding to Maxwellian distributions with temperatures of about 1.0 MeV for the $Ni^{58}(n,p)$ reaction and about 0.5 MeV for the $Ni^{58}(n,p) + Ni^{58}(n,np)$ reaction. The total cross-section determined from this data is 440 mb ± 10%.

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9683 SPECTRA OF SECONDARY NEUTRONS PRODUCED IN THE PASSAGE OF 14 MeV NEUTRONS THROUGH LAYERS OF FISSILE MATERIAL.
Yu.S.Zamyatnin, I.N.Safina, E.K.Gutnikova and N.I.Ivanova.
J. Nuclear Energy, Vol. 9, No. 1-4, 194-9 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 337 (1958).

Measurements are presented of the energy spectra of secondary neutrons formed in layers of Th^{232}, U^{233}, U^{235}, U^{238} and U^{239} and Pu^{239} under bombardment by 14 MeV neutrons. It is shown that all the spectra contain two components, characteristic, respectively, of fission and evaporation processes. The coefficients involved in resolving the spectra into their components have been expressed as a function of the nuclear constants.

539.17

9684 SLOW NEUTRON SCATTERING BY THE TITANIUM ISOTOPES. C.G.Shull, M.K.Wilkinson and M.H.Mueller.
Phys. Rev., Vol. 118, No. 3, 797-8 (May 1, 1960).

Neutron diffraction studies are reported on isotopically enriched samples of TiO from which are evaluated the coherent scattering amplitudes of the titanium isotopes. Scattering amplitudes of + 0.48, + 0.33, - 0.58, + 0.08, and + 0.55 × 10^{-12} cm were established for the titanium isotopes of mass 46, 47, 48, 49, and 50, respectively. The major isotope Ti^{48} is thus responsible for the anomalous scattering amplitude, - 0.34 × 10^{-12} cm, characteristic of the normal element. Pronounced nuclear scattering resonance effects on the observed neutron scattering are suggested to occur for most of the isotopes.

539.17

9685 SLOW NEUTRON RESONANCE SPECTROSCOPY. I. U^{238}.
J.L.Rosen, J.S.Desjardins, J.Rainwater and W.W.Havens, Jr.
Phys. Rev., Vol. 118, No. 3, 687-97 (May 1, 1960).

The spectrometer system described in Abstr. 9381 of 1960 was employed. The results of time-of-flight measurements of U^{238} resonances in the region 90-1300 eV are presented and resonance parameters for levels up to 1000 eV are obtained. Neutron widths for the 55 observed levels and radiation widths for 32 of the stronger levels are deduced. The deduced neutron width distribution is found to be in good agreement with the theoretical prediction of Porter and Thomas for a single channel process, while the level spacing distribution agrees with the "repulsion" formula suggested by Wigner. The average value of the radiation widths was found to be (24.6 ± 0.8) × ×10^{-3} eV, while the average reduced neutron width and level spacing were found to be (1.76 ± 0.26) × 10^{-3} eV and 18.5 ± 1.3 eV, respectively. These values are in good agreement with earlier results reported by other workers. A strength function of (0.95 ± 0.15) ×10^{-4} is obtained. It appears on the basis of their size and number, that several of the weaker levels may be due to p-wave neutrons.

539.17

9686 THEORY OF ALLOWED AND FORBIDDEN TRANSITIONS IN MUON CAPTURE REACTIONS.
M.Morita and A.Fujii.
Phys. Rev., Vol. 118, No. 2, 606-18 (April 15, 1960).

A general formula for the transition rate of the muon capture reaction, $\mu^- + (A,Z) \rightarrow \nu + (A, Z-1)$, where the final nuclear state has definite spin and parity, is given in terms of the total and orbital angular momenta of the emitted neutrino and of the spins of the initial

and final nuclear states. The induced pseudoscalar interaction and the interaction due to the assumption of conserved vector current are taken into account, together with the vector and axial vector interactions. The forbiddenness of the muon capture reaction is defined in a manner analogous to the theory of the beta decay. The spin and parity changes can assume the values (0+, 1+), (0−, 1−, 2−), $[n(-)^n$, $n+1\ (-)^n]$ for the allowed, first forbidden, and n-th ($n \geq 2$) forbidden transitions, respectively. (+ and − mean the parity change "no" and "yes"). For these transitions, the number of reduced nuclear matrix elements involved is nine, sixteen, and fourteen, respectively. The transition rate of muon capture reaction is reduced by a factor of 10^3, approximately, for a two-unit increase of the forbiddenness, if the atomic number and the energy of neutrino are constant. The contribution from the higher order transition to the lower one is less than 0.1% in the medium and light nuclei. Explicit formulae for the transition rate are given for the allowed, first forbidden and n-th forbidden transitions. They are related to the corresponding formulae of beta decay. This formalism was applied to the calculation of the partial muon capture rate by C^{12} ending in the ground state of B^{12}. The numerical analysis indicates that measurement of this capture rate can determine whether the conserved vector current interaction term exists in nature only if the coupling constant of the induced pseudoscalar interaction and the nuclear wave-functions are well known. The transition rates are given for the j−j coupling shell model and harmonic oscillator wave-functions. They are 9-13% smaller than those given by Fujii and Primakoff. (Abstr. 8472 of 1959)

539.17

9687 ABSORPTION OF [UNPOLARIZED] μ-MESONS BY POLARIZED NUCLEI. ANGULAR DISTRIBUTION OF THE NEUTRONS. E.I.Dolinskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1179-84 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 838-42 (Oct , 1959).

539.17

9688 CIRCULAR POLARIZATION OF GAMMA QUANTA EMITTED BY A NUCLEUS AFTER μ-CAPTURE.
I.S.Shapiro and L.D.Blokhintsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 760-4 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 542-5 (March, 1960).

Formulae for the circular polarization are deduced. The hyperfine splitting of the mesic atom levels is taken into account.

539.17

9689 RADIATIVE CAPTURE OF POLARIZED μ^- MESONS BY NUCLEI. G.M.Gandel'man and V.N.Mokhov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1513-16 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1073-5 (Nov., 1959).

The correlation between the direction of the μ-meson spin and the direction of emission of the photon in the radiative capture of μ-mesons by nuclei is considered, taking into account the interaction between the μ-meson and the nuclear spin (hyperfine splitting). The analysis is carried out for nuclei of arbitrary spin J.

539.17

9690 THE MECHANISM OF CAPTURE OF STOPPED K^- MESONS.
D.K.Kopylova, Yu.B.Korolevich, N.I.Petukhova and M.I.Podgoretskii.
Zh. eksper. teor. Fiz., Vol. 37 No. 1(7), 289-91 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 203-5 (Jan., 1960).

The capture of stopped K^- mesons by the nuclei of a photographic emulsion. On the assumption of a surface model of one-nucleon capture, it is found that the fraction of two-nucleon captures is close to 30 per cent.

539.17

9691 SOME RESULTS CONCERNING HEAVY UNSTABLE NUCLEAR FRAGMENTS EJECTED FROM INTERACTION OF 4.5 GeV π^- IN EMULSION. M.De Pretis and G.Poiani.
Nuovo Cimento Suppl., Vol. 15, No. 3, 265-81 (1960).

An extensive account of a study of the nature, emission spectra, and angular distributions of unstable nuclear fragments and hyperfragments produced in interactions of 4.5 GeV π^- with heavy elements of the emulsion. The work is based on about 36 000 stars with at least 5 black prongs. Consideration is given to the fragments Li^8, Li^9, Be^8, Be^9, B^8, C^{12}, B^{12}. There are also 29 Λ^0-hyperfragments.
S.J.Goldsack

539.17

9692 CAPTURE OF μ^--MESONS BY LIGHT NUCLEI. B.L.Ioffe.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 159-63 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37 (10), No. 1, 113-16 (Jan., 1960).

Different effects in the capture of μ^--mesons by light nuclei, without neutron or proton emission, are calculated. It is assumed that the interaction is described by the A and V coupling variants. Corrections of first order in nucleon velocity and in $(R/\lambda)^2$ are taken into account and turn out to be quite significant. The results of the calculation contain one unknown constant, in addition to the usual matrix element, so that at least two experiments are necessary to verify the theory.

539.17

9693 ELASTIC SCATTERING OF 5-22 MeV π^+-MESONS ON CARBON.
V.G.Kirillov-Ugryumov, L.P.Kotenko, E.P.Kuznetsov, F.M.Sergeiev and A.F.Grashin

Elastic scattering of 5-22 MeV π^+-mesons on carbon in a propane bubble chamber was investigated. A phase-shift analysis of the angular distributions shows that a repulsive potential acts on the meson in the S-state of the nucleus.

539.17

9694 ABSORPTION OF π^+ MESONS WITH AN ENERGY OF ABOUT 50 MeV BY CARBON NUCLEI.
J.V.Laberrig-Frolova [Laberrigue-Frolow], M.P.Balandin and S.Z.Otvinovskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 634-8 (Sept., 1959). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 37 (10), No. 3, 452-5 (March, 1960).

Stars arising from the absorption of π^+-mesons with an energy of 50 ± 20 MeV in carbon nuclei were investigated with the aid of a propane bubble chamber. The formation cross-section of such stars was 145 ± 36 mb. The distribution of the stars according to the number of prongs was obtained, the average number of prongs being 2.6 ± 0.3. A significant anisotropy in the angular distribution of prongs relative to the direction of motion of the π^+-meson was observed. The basic source of this anisotropy was evidently a preabsorption scattering of π^+-mesons from the individual nucleons inside the nucleus. The distribution of two-pronged stars by angles between the prongs is given.

539.17

9695 ABSORPTION OF NEGATIVE MUONS IN C^{12} LEADING TO PRODUCTION OF BOUND B^{12}.
J.G.Fetkovich, T.H.Fields and R.L.McIlwain.
Phys. Rev., Vol. 118, No. 1, 319-24 (April 1, 1960).

A μ^- beam from the Carnegie Tech synchrocyclotron was stopped in a 6 in. propane bubble chamber. Since the hydrogen does not form μ-mesonic atoms in the presence of carbon, the pictures yield information on the interaction of stopped muons with carbon. About 30 000 pictures of stopping muons were taken with the bubble chamber kept sensitive for ~ 20 msec after the beam pulse in order to observe the beta decay of any bound B^{12} nuclei resulting from μ absorption by carbon. The chamber was photographed right after the beam pulse to determine whether a given stopped muon decayed, or was absorbed. Another photograph was taken about 15 msec later to determine if the absorption had led to a nucleus which had beta decayed. A count of μ−e decays in the same film allowed the determination of the probability per unit time of bound B^{12} formation. Forty-six boron decays were observed yielding $(7.6 \pm 1.2) \times 10^3\ sec^{-1}$ for the rate of bound B^{12} production. Possible interpretation of this result in terms of a universal V−A Fermi interaction is discussed.

539.17

9696 SINGLE SCATTERING OF 10-30 MeV μ^--MESONS ON CARBON. A.I.Alikhanyan, V.G.Kirillov-Ugryumov, L.P.Kotenko, E.P.Kuznetsov and A.V.Samoilov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 387-93 (Feb., 1960). In Russian.

Single scattering of μ^--mesons in a propane bubble chamber was measured. About 60000 μ^--meson stoppages were measured. For the scattering analysis 48100 stopped μ^--mesons possessing

energies between 10 and 30 MeV were chosen. Observations were carried out on 1260 carbon nuclear path lengths traversed by the μ^--mesons. The differential angular distribution can be satisfactorily described by a Mott scattering curve is the finite size of the nucleus is allowed for. The present experiment shows that the cross-section for "anomalous" scattering (if it exists) through an angle $> 45^\circ$ cannot exceed 1.25×10^{-28} cm^2 per nucleon for the energies under consideration and does not exceed 0.7×10^{-28} cm^2 per nucleon for scattering through an angle $> 90^\circ$. Not one case of μ^--decay of the $\mu^- \rightarrow e^+ + e^- + e^-$ type was detected in the 60000 stoppage events.

539.17

9697 INELASTIC INTERACTION OF $\pi^\pm$-MESONS WITH HELIUM NUCLEI AT AN ENERGY OF ABOUT 300 MeV. M.S.Kozodaev, M.M.Kulyukin, R.M.Sulyaev, A.I.Filippov and Yu.A.Shcherbakov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 409-22 (Feb., 1960). In Russian.

Interaction of positive and negative π-mesons with helium nuclei at energies of 273 MeV and 330 MeV respectively was studied with aid of a diffusion cloud chamber. Quasi-free scattering on neutrons and protons, multiple scattering and absorption of the mesons were identified. The total inelastic interaction cross-sections were $(145 \pm 15) \times 10^{-27}$ cm^2 for E_π = 273 MeV and $(103 \pm 10) \times 10^{-27}$ cm^2 for E_π = 330 MeV. The relative probabilities for quasi-free scattering on neutrons and protons through angles $> 45^\circ$ in the laboratory coordinate system are found to agree with the corresponding probabilities for scattering on free nucleons. The probabilities for multiple scattering processes were found equal to 0.24 ± 0.06 for E_π = 273 MeV and 0.29 ± 0.05 for E_π = 330 MeV. The experimental results confirm current ideas concerning the dominant role of np-pairs in absorption of π-mesons by nuclei. The angular distribution of π-mesons by nuclei. The angular distribution of inelastically scattered π-mesons is compared with the Watson–Zemach calculations.

539.17

9698 ANGULAR ANISOTROPY OF GAMMA QUANTA THAT ACCOMPANY FISSION. V.M.Strutinskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 861-3 (Sept., 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 37(10), No. 3, 613-15 (March, 1960).

It is suggested that the anisotropy of the emission of gamma quanta relative to the direction of the fragments in fission may be due to the presence of large fragment angular momentum correlated with the fission direction. The predicted anisotropy is found to be in reasonable agreement with experimental values. C.J.Batty

539.17

9699 ANGULAR DISTRIBUTION OF FRAGMENTS FROM THE FISSION OF BISMUTH BY 450-MeV PROTONS. M.V.Ramaniah and N. Sugarman.
Phys. Rev., Vol. 118, No. 2, 562-3 (April 15, 1960).

Test experiments were performed on the "bead-cone" method (Abstr. 8844 of 1957) used for the measurement of the angular distribution of fission fragments from the 450 MeV proton fission of bismuth. These experiments make doubtful the conclusions of a previous measurement.

539.17

9700 A STUDY OF THE VARIATION WITH INCIDENT NEUTRON ENERGY OF THE RELATIVE PROBABILITY OF TERNARY FISSION WITH THE EMISSION OF A LONG-RANGE α-PARTICLE. J.M.Auclair.
J. Phys. Radium, Vol. 19, No. 1, 68-9 (Jan., 1958). In French.

No variation was observed with U^{235} within the statistical accuracy of the experiment.

539.17

9701 FISSION OF Th^{232} INDUCED BY THERMAL NEUTRONS. E.I.Korneev, V.S.Skobkin and G.N.Flerov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 41-5 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 29-32 (Jan., 1960).

It is shown that the fission effect which occurs when thorium is irradiated with slow neutrons is in fact due to the fission of Th^{232} by thermal neutrons. The fission cross-section is (0.06 ± 0.02) mb. The results obtained are compared with available experimental data on the fission of even–even nuclei by thermal neutrons.

539.17

9702 Th^{232} FISSION INDUCED BY 14.9 MeV NEUTRONS. A.N.Protopopov, M.I.Kuznetsov and E.G.Dermendzhiev.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 384-6 (Feb., 1960). In Russian.

The energy characteristics of Th^{232} fission induced by 14.9 MeV neutrons were measured with a double ionization chamber with grids. The most probable total kinetic energy and fragment mass ratio were measured and found to (157 ± 4) MeV and 1.43 ± 0.05 respectively. The most probable values of the masses of the heavy and light fission fragments are 140 ± 3 and 92 ± 3. Data are obtained which confirm the influence of nuclear shells on fission.

539.17

9703 SLOW NEUTRON TOTAL AND FISSION CROSS SECTIONS OF U^{233}. M.S.Moore, L.G.Miller and O.D.Simpson.
Phys. Rev. Vol. 118, No. 3, 714-17 (May 1, 1960).

The slow-neutron total and fission cross-sections were measured from 0.02 to 200 eV on the MTR (Materials Testing Reactor) fast chopper. The strong resonances are resolved below a neutron energy of 15 eV, and show marked interference effects in the fission cross-section. No resonances are observed in the total cross-section which are not also present in the fission cross-section, except for those attributed to the known contaminants in the samples. An estimate of the neutron strength function $\langle \Gamma_n^0/D \rangle$, made by an area analysis, gives the value $(1.0 \pm 0.2) \times 10^{-4}$ for this energy region in U^{233}.

539.17

9704 MULTILEVEL ANALYSIS OF THE SLOW NEUTRON CROSS SECTIONS OF U^{233}. M.S.Moore and C.W.Reich.
Phys. Rev., Vol. 118, No. 3 718-24 (May 1, 1960).

A multilevel analysis of the slow-neutron total and fission cross-sections of U^{233} from thermal energies to 11 eV has been carried out, under the assumption that in one of the two spin states the nucleus undergoes fission primarily through a small number of channels. The cases of one and of two fission channels for this spin state have been investigated in detail. Although the analysis does not yield an exact value for the number of available fission channels, the data are adequately fit with a two fission channel formula. It is not necessary to invoke any negative energy resonances in the analysis. The presence of a noninterfering component in the cross-sections, having a 1/v energy variation, is indicated. At thermal energies, this component accounts for approximately 80% of the total and fission cross-sections. An interpretation of this component as being due to one spin state of the compound nucleus is presented. Under this assumption, the fission characteristics of the two spin states of the compound nucleus formed by s-wave neutrons are quite different.

539.17

9705 PRECISION MEASUREMENT OF THE TOTAL NEUTRON CROSS SECTION OF U^{233} BETWEEN 0.000818 AND 0.0818 eV. G.J.Safford, W.W.Havens, Jr and B.M.Rustad.
Phys. Rev., Vol. 118, No. 3, 799-802 (May 1, 1960).

The absolute value of the total neutron cross-section of U^{233} was measured at neutron energies between 0.000818 and 0.0818 eV for two types of samples, a metallic foil and D_2O solutions or uranium nitrate. Balanced solutions of $U^{233}O_2(NO_3)_2$ and $U^{235}O_2(NO_3)_2$ were used to determine the difference between the total cross-sections of U^{233} and U^{235}. This value when combined with the relatively small known value of the total cross-section for U^{235} gives $\sigma_T(U^{233}) = 587 \pm 5$ barns at 0.0253 eV. The measurements on the metallic U^{233} foil agreed with the measured total cross-section determined from the liquid solution data to better than 1%, yielding $\sigma_T(U^{233}) = 586 \pm 2$ barns at 0.0253 eV.

539.17

9706 LOW-ENERGY NEUTRON CROSS SECTIONS OF FISSIONABLE NUCLEI. E.Vogt.
Phys. Rev., Vol. 118, No.3, 724-33 (May 1, 1960).

The method of analysis developed in a previous paper (Abstr. 5073 of 1959) is applied to the low-energy neutron cross-sections of the common fissionable isotopes. Further evidence is presented to show that U^{235} possesses the unusual negative energy level required by the previous analysis. However, good fits are obtained for the cross-sections of both U^{233} and Pu^{239} without such an unusual bound level, suggesting that the neutron resonance cross-sections of the fissionable isotopes do not exhibit a basic anomaly. The size of the level interference effects in each of the isotopes implies that the fission process involves more than one but no more than a few fission channels.

539.17

9707 THE YIELD OF Ba^{140} IN THE THERMAL NEUTRON FISSION OF U^{235}. D.C.Santry and L.Yaffe.
Canad. J. Chem., Vol. 38, No. 3, 464-6 (March, 1960).

Uranium trioxide was irradiated simultaneously with a cobalt sample as flux monitor, and the resulting activities measured by 4π β-counting, after chemical separation. The fission yield of Ba^{140} was found to be 6.36 ± 0.12%, in good agreement with earlier work.
A.E.I. Research Laboratory

539.17

9708 MEASUREMENTS OF THE MEAN NUMBER OF NEUTRONS EMITTED DURING FISSION OF U^{233} BY 14.2 MeV NEUTRONS.
S.Blaise, M.Gaudin, R.Joly, J.Leroy and G.Vendryes.
J. Phys. Radium, Vol. 19, No. 1, 66-7 (Jan., 1958). In French.

The ratio ν/ν' was measured, where ν and ν' are the mean number of neutrons emitted by fission of U^{233} with 14.2 MeV neutrons, and the number of neutrons emitted by fission of U^{235} with thermal neutrons, respectively.

539.17

9709 THE MECHANISMS OF URANIUM FISSION INDUCED BY SLOW μ-MESONS.
G.E.Belovitskii, N.T.Kashchukeev, A.Mikhul, M.G.Petrashku, T.A.Romanova and F.A.Tikhomirov.
Zh. eksper. teor. Fiz., Vol. 38, No. 2, 404-8 (Feb., 1960). In Russian.

Photographic emulsions were employed to study the possibility of uranium fission produced as a result of direct transfer to the nucleus of the energy liberated in the 2p–1s mesic atom transition. The upper limit of the probability for fission by this mechanism is ~ 0.01. The other mechanism of uranium fission proceeds mainly by nuclear capture of the μ^--meson, the probability for this being of the order of 0.07. Arguments are presented which indicate that the mesic atom 2p–1s transition in uranium is partially a radiationless transition.

539.17

9710 FISSION OF Ra^{226} BY DEUTERONS AND HELIUM IONS. R.C.Jensen and A.W.Fairhall.
Phys. Rev., Vol. 118, No. 3, 771-5 (May 1, 1960).

Fission induced in Ra^{226} by 14.5 and 21.5 MeV deuterons, and by 23.5, 31, and 43 MeV He ions, was studied using radiochemical techniques. The mass distributions of fission products for deuteron-induced fission is triple-humped, corresponding to separate symmetric and asymmetric fission modes. The symmetric mode dominates at the higher bombarding energy. The mass distributions observed for fission products from He-ion induced fission look more "normal": asymmetric at the lowest bombarding energy, becoming a single broad peak at the highest bombarding energy. These results are interpreted in terms of a symmetric fission mode which increases strongly with increasing excitation energy, and an asymmetric fission mode which occurs mainly at low excitation energies following neutron evaporation from highly excited compound nuclei. Asymmetric fission is interpreted to be disappearing as a fission mode for nuclei of lower atomic number than thorium.

539.17

9711 FORMATION OF THE Cd^{115m} ISOMER BY FISSION OF GOLD BY HEAVY IONS.
S.M.Polikanov and Yu.T.Chuburkov.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 295-6 (Jan., 1960). In Russian.

Au^{197} was bombarded with ionized O^{16}, N^{14}, and C^{12} of various energies and the yields of Cd^{115} (half-life 2.3 days, $I = \frac{1}{2}$) and Cd^{115m} 43 days, $I = \frac{11}{2}$) formed from the β-decay of Ag^{115} (half-life 20 min.) were measured. The yield was found to be a decreasing function of l_{max}, the maximum orbital angular momentum of an ion compatible with collision with the target nucleus.
J.W.Gardner

539.17

9712 ANGULAR DISTRIBUTION OF FISSION FRAGMENTS IN FISSION INDUCED BY HEAVY IONS.
V.A.Druin, Yu.V.Lobanov and S.M.Polikanov.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 38-40 (July, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 26-8 (Jan., 1960).

The ratio of the yield of fission fragments emitted at angles of 135 and 90° was measured in the fission of gold nuclei induced by carbon and oxygen ions and also in the fission of U^{238} by carbon ions. Measurements were made of the ranges of the fission fragments from the same two reactions. Experimental values of the coefficient of anisotropy of the fission fragments are compared with theoretical values obtained on the basis of statistical theory.

539.17

9713 SOME FEATURES OF THE SPONTANEOUS FISSION OF U^{238}. B.D.Kuz'minov, L.S.Kutsaeva, V.G.Nesterov, L.I.Prokhorova and G.P.Smirenkin.
Zh. eksper. teor. Fiz., Vol. 37, No. (8), 406-12 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 290-4 (Feb., 1960).

The average number of neutrons emitted per event of spontaneous U^{238} fission, $\bar{\nu} = 2.1 \pm 0.1$, and the quantity $\Delta = (\bar{\nu}^2 - \bar{\nu})/\bar{\nu}^2 = 0.95 \pm 0.05$, which characterizes the neutron distribution, were measured by a double-coincidence technique. These values, as well as the results of previous studies of neutron emission from spontaneous U^{238} fission do not agree with the semi-empirical laws valid for most investigated nuclei. The number of neutrons emitted was determined to be 64.5 ± 2.0 per gram-hour. The decay constant and spontaneous fission half-life computed from the data obtained in the present investigation are 31 ± 1.5 fissions per gram-hour and $(6.5 \pm 0.3) \times 10^{15}$ years, respectively.

NUCLEAR POWER STUDIES

539.17 : 621.039

9714 THE ERECTION OF REACTORS AT RISØ. E.Bryrup, A.K.Pedersen, E.A.Christiansen, K.Friis-Møller and E.Jacobsen.
Ingeniøren B, Vol. 69, No. 3, 110-21 (Feb. 1, 1960). In Danish.

Describes the erection of the DR1 reactor, which is a zero-energy equipment with an output of only about 2 kW. The reactivity falls when temperature rises, thus greatly reducing the risks of operational accidents. The construction is simplified in consequence and safety equipment is required only to a lesser extent. The construction of the concrete radiation shield, welding of the stainless steel tubing, cleanliness problems, instrumentation, control rod system and layout of the reactor hall are described.
G.N.J.Beck

539.17 : 621.039

9715 THE ERECTION OF REACTORS AT RISØ. THE DR2 PLANT. E.Bryrup, A.K.Pedersen, E.A.Christiansen, K.Friis-Møller and E.Jacobsen.
Ingeniøren B, Vol. 69, No. 4, 144-64 (Feb. 15, 1960). In Danish.

For Pt I see preceding abstract. DR2 is a research reactor which can be used on a small scale for the testing of materials, preparation of radioactive isotopes and production of neutron beams. It is cooled and moderated with ordinary water and has a neutron flux of 5×10^{13} n/cm²/sec at 5 MW. Its core consists of 30 fuel elements, each consisting of 18 thin plates in which an Al-U alloy containing highly enriched uranium is pressed between two Al layers. The core is enclosed in an Al tank which is filled with water. The design of the tank, primary cooling circuit, purification methods, radiation screening methods, design of the reactor hall, air conditioning and decontamination plants and the electrical installation are discussed.
G.N.J.Beck

539.17 : 621.039

9716 THE ERECTION OF REACTORS AT RISØ. THE DR3 PLANT. E.Bryrup, O.Nielsen, E.H.Jensen, B.Mütze, E.A.Christiansen, K.Friis-Møller and E.Jacobsen.
Ingeniøren B, Vol. 69, No. 6, 196-218 (March 15, 1960). In Danish.

For previous parts see preceding abstracts. The DR3 is based on the British Pluto reactor at Harwell. It is a research reactor for testing active materials. It became critical on 17.1.60. Highly enriched U is used as a fuel and heavy water as moderator and coolant; the max. thermal flux is about 1.5×10^{14} n/cm²/sec with thermal generation of 10 MW. The reactor core contains 26 Al-canned U elements in an Al tank closed above by a 1.2 m Al top shield, carrying the control rods and various experimental tubes. At the sides and bottom of the Al tank there is a 30 cm thick graphite reflector. Besides the heavy water system, there are two helium systems, one to prevent combination between heavy water and the atmosphere, the other to surround the graphite reflector. A detailed description is given of all these features, as well as auxiliary services. A 10/0.4 kV transformer substation is installed on the site.
G.N.J.Beck

539.17

9717 REACTOR INCIDENTS AT SACLAY. P.Balligand.
Nucleonics, Vol. 18, No. 3, 82-5 (March,1960).

In April 1958 a uranium fuel rod in EL3 (a 15 MW heavy water cooled and moderated reactor) fell from its normal position and melted. Radioactive rare gases escaped into the cover gas but the other fission products remained in the water and were extracted with ion-exchange resins. Several fuel cladding failures in EL2 (heavy water moderated, CO_2 cooled) have occurred but have not caused serious damage. R.D.Smith

539.17

9718 CALCULATING GAMMA SPECTRA FROM REACTORS. R.L.French.
Nucleonics, Vol. 18, No. 3, 114, 116, 117 (March, 1960).

A method based on the differential γ-energy spectrum produced by isotropic point sources in infinite media. A reactor is treated as an array of point sources and the effect of successive layers of material calculated in turn. The method is illustrated by comparison of measured and calculated data for the Convair Ground Test reactor and the Oak Ridge Bulk Shielding Reactor (see also following abstract). R.D.Smith

539.17

9719 FAST-NEUTRON AND GAMMA SPECTRA FOR B.S.R. R.L.French and J.B.Eggen.
Nucleonics, Vol. 18, No. 3, 117, 118, 120 (March, 1960).

See preceding abstract. Gamma spectra were calculated by the new method and neutron spectra, using the removal cross-section. The results are tabulated in full, and good agreement with experiment is obtained. R.D.Smith

539.17

9720 SCREENING OF FUEL ELEMENTS AT NEUTRON ABSORPTION RESONANCES IN A CLOSE-PACKED LATTICE. V.V.Orlov.
J. nuclear Energy, Vol. 9, No. 1-4, 281-92 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 531 (1958).

The degree of mutual screening by resonance absorbing slugs or layers of fuel is calculated for the case where the thickness of moderator between adjacent elements is comparable with or less than the neutron mean free path in the moderating material. It is assumed that the fuel elements are small and that the absorption cross-section follows the Briet-Wigner law. Computations are made for a system of parallel plates; they provide a check on the accuracy of Petrov's earlier formulae, and lead to an expression for the screening coefficient of a nearly homogeneous system. The normally justifiable approximation of replacing the true cell in a lattice of cylindrical elements by a supposedly equivalent cell of circular section is shown to introduce substantial errors in problems of this type. An explicit formula is derived for the resonance self-absorption in elements of annular cross-section.

539.17

9721 VOLUME INCREASES IN FISSILE MATERIALS ON NEUTRON IRRADIATION AND THE EFFECTS OF THERMAL FLUCTUATIONS. G.W.Greenwood.
J. Brit. Nuclear Energy Conf., Vol. 5, No. 2, 82-8 (April, 1960).

When fissile materials are irradiated above 450°C in nuclear reactors, significant increases in volume occur as a result of the accumulation of fission-product gases in cracks or as bubbles which grow by creep of the surrounding matrix, though in some cases surface-tension forces exert a strong restraint. In the range 450°-650°C, volume increases in specimens of α-uranium structure are generally greater than in those of cubic structure and are too large to be accounted for in terms of conventional creep-test data. There is some correlation between volume increases in α-uranium and thermal fluctuations during irradiation. This can be interpreted in terms of the enhanced creep of a polycrystalline anisotropic material when subjected to temperature fluctuations, both small ($\sim \pm 10°C$) and when sufficiently great ($\sim \pm 50°C$) to produce intergranular stresses exceeding the yield stress.

539.17

9722 DISPERSIONS OF URANIUM CARBIDES IN ALUMINUM FOR PLATE-TYPE FUEL ELEMENTS REQUIRING HIGH-URANIUM CONCENTRATIONS. W.C.Thurber and R.J.Beaver.
J. nuclear Mater., Vol. 1, No. 3, 226-32 (Oct., 1959).

Uranium carbides are potential fissile dispersoids for aluminium-base fuel elements in which the isotopic enrichment in U^{235} is limited to 20%. Uranium dicarbide appears to be wholly compatible with aluminium at 600°C. Uranium monocarbide, on the other hand, is chemically active under the same conditions and is converted to the uranium–aluminium intermetallic compounds UAl_3 and UAl_4. Plate-type fuel elements containing dispersions of UC_2 in aluminium can be manufactured using established procedures with the exception that the cores must be vacuum degassed prior to rolling into fuel plates. Corrosion testing in 60°C water indicates that UC_2–Al dispersions will corrode catastrophically if the fuel-bearing section is inadvertently exposed to reactor process water.

539.17

9723 SLIDE RULE SIMPLIFIES XENON COMPUTATIONS. D.E.Dickey and J.E.McEwen.
Nucleonics, Vol. 18, No. 2, 88, 90, 92-3, 95 (Feb.,1960).

A special slide rule which can be used to calculate the reactivity absorbed by the Xenon build-up after shutdown of a power reactor is described and its mathematical basis explained. The operating power of the reactor for the 50 hours prior to the shutdown is averaged for 12 time intervals and an accuracy of 2% is obtained. R.D.Smith

539.17

9724 SHOCK WAVES AND CONTROLLED THERMONUCLEAR FUSION. J.K.Wright.
Proc. Phys. Soc., Vol. 75, Pt 3, 412-20 (March, 1960).

An assessment is given of the various types of thermonuclear device based on shock heating. The classical shock heating process in which the mean free path in the shocked gas is much smaller than the dimensions of the apparatus is analysed and it is shown that shock heating alone is unlikely to yield temperatures in excess of the order of 3×10^8 deg K with present-day techniques. The temperature may be increased in principle to a value required for power production by isentropic compression after the shock heating phase. The so-called Z-pinch types of apparatus are limited by the growth of instabilities whereas the θ-pinch devices are limited by the difficulty of recovering energy without undue ohmic losses.

539.17 : 538.3

ELECTRON MOTION CALCULATION RELEVENT TO THE THERMONUCLEAR MACHINE "ASTRON". See Abstr. 9156

ATOMS

539.18

9725 A REFINEMENT OF THE THOMAS–FERMI MODEL AT SMALL DISTANCES [FROM THE NUCLEUS]. E.S.Fradkin.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1533-5 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1087-8 (Nov., 1959).

This correction leads to a significant improvement in the agreement between the calculated and experimental values of the total energy of atoms.

539.18

9726 THE PRESSURE DEPENDENCE OF THE ANGULAR MOMENTUM OF ATOMS. P.Gombás.
Acta. phys. Hungar., Vol. 8, No. 3, 315-19 (1958). In German.

Using the statistical models of Thomas and of Fermi the pressure dependence of the angular momentum of atoms at the absolute zero of temperature has been calculated. W.J.Orville-Thomas

539.18

9727 APPLICATION OF THE VARIATIONAL PRINCIPLE FOR THE DETERMINATION OF THE BINDING ENERGY OF A PROTON–ELECTRON–POSITRON SYSTEM. V.P.Shmelev.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 458-66 (Aug., 1959). In Russian. English translation in : Soviet Physics – JETP (New York), Vol. 37(10), No. 2, 325-31 (Feb., 1960).

The energy was found to be $E \leq 0.563$ Ry. The system can only dissociate into a proton and a positronium atom, with the dissociation energy $|\epsilon| \geq 0.063$ Ry.

539.18 : 539.19

9728 THE DENSITY MATRIX IN MANY-ELECTRON QUANTUM MECHANICS. I. GENERALIZED PRODUCT FUNCTIONS. FACTORIZATION AND PHYSICAL INTERPRETATION OF THE DENSITY MATRICES. R.McWeeny.
Proc. Roy. Soc. A, Vol. 253, 242-59 (Nov. 24, 1959).

Many-electron wave-functions are usually constructed from antisymmetrized products of one-electron orbitals (determinants) and energy calculations are based on the matrix element expressions due to Slater (1931). In this paper, the orbitals in such a product are replaced by "group functions", each describing any number of electrons, and the necessary generalization of Slater's results is carried out. It is first necessary to develop the density matrix theory of N-particle systems and to show that for systems described by "generalized product functions" the density matrices of the whole system may be expressed in terms of those of the component electron groups. The matrix elements of the Hamiltonian between generalized product functions are then given by expressions which resemble those of Slater, the "coulomb" and "exchange" integrals being replaced by integrals containing the one-electron density matrices of the various groups. By setting up an "effective" Hamiltonian for each electron group in the presence of the others, the discussion of a many-particle system in which groups or "shells" can be distinguished (e.g. atomic K, L, M,....., shells) can rigorously be reduced to a discussion of smaller subsystems. A single generalized product (cf. the single determinant of Hartree–Fock theory) provides a convenient first approximation; and the effect of admitting "excited" products (cf. configuration interaction) can be estimated by a perturbation method. The energy expression may then be discussed in terms of the electron density and "pair" functions. The energy is a sum of group energies supplemented by interaction terms which represent (i) electrostatic repulsions between charge clouds, (ii) the polarization of each group in the field of the other, and (iii) "dispersion" effects of the type defined by London. All these terms can be calculated, for group functions of any kind, in terms of the density matrices of the separate groups. Applications to the theory of intermolecular forces and to π-electron systems are also discussed.

539.18

9729 PERTURBATION THEORY FOR ATOMIC SYSTEMS. A.Dalgarno.
Proc. Roy. Soc. A, Vol. 251, 282-90 (May 26, 1959).

The equations of the Hartree and Hartree–Fock formulations for a perturbed atomic system are discussed. It is pointed out that there are two alternative procedures, one of which is correct to first order in the error of the unperturbed wave-function, but not the other, and explicit expressions are written down for the error in the derived perturbed energies in the two cases. A quantitative assessment of the accuracy of the two procedures is provided by the calculation of the dipole and quadrupole polarizabilities of helium, a variation-iteration method being used to solve the relevant equations.

539.18

9730 LAMB SHIFT OF A TIGHTLY BOUND ELECTRON. I. METHOD. G.E.Brown, J.S.Langer and G.W.Schaefer.
Proc. Roy. Soc. A, Vol. 251, 92-104 (May 12, 1959).

A method for calculating the Lamb shift of an inner electron in a heavy atom is developed. This method contains only an expansion in α, the coupling of the electron with the radiation field, but not in $Z\alpha$, where Z is the atomic number. Since the calculation is essentially non-covariant, care must be taken in eliminating divergent terms. A "correct" finite part of the Lamb shift is obtained, and put into a form suitable for calculation.

539.18

9731 LAMB SHIFT OF A TIGHTLY BOUND ELECTRON. II. CALCULATION FOR THE K-ELECTRON IN MERCURY. G.E.Brown and D.F.Mayers.
Proc. Roy. Soc. A, Vol. 251, 105-9 (May 12, 1959).

The Lamb shift of a K-electron in mercury is calculated using the method described in the preceding abstract. It is found to be 38 Ry. Together with results of theoretical calculations of all other effects of order mc^2 and αmc^2, this gives a theoretical binding energy of −6099 Ry, which may be compared with the experimental value of −6107.7 ± 0.6 Ry for the K-absorption edge. Theoretical contributions of order $\alpha^4 mc^2 (\alpha^2 mc^2 = 2$ Ry) are discussed, but not evaluated.

539.18

9732 LIMITING BEHAVIOUR OF ATOMIC WAVE FUNCTIONS FOR LARGE ATOMIC NUMBER. III. C.Froese.
Proc. Roy.Soc. A, Vol. 251, 534-5 (June 23, 1959).

For Pt II, see Abstr. 4364 (1958). Results for limiting screening number as $N \to \infty$ of an electron in the (nl) radial wave function of an atom with atomic number N, are extended to configurations including (4s), (4p) and (4d) electrons. The limiting slope of the screening number as a function of the mean radius of the wave function is given for the $(4s)^2(4p)^6$ configuration.

539.18

9733 THE CALCULATION OF THE DIFFERENTIAL ELASTIC CROSS SECTION FOR COMPLEX ATOMS FOR THE SELF-CONSISTENT FIELD. T.Tietz.
Acta phys. Hungar., Vol. 10, No. 2, 251-2 (1959).

This cross-section is found analytically for the collision of an electron with a spherically symmetric atom, using Gáspár's approximate analytic form for the Hartree–Fock function (Abstr. 9525 of 1954). J.Hawgood

539.18

9734 HARTREE–FOCK EQUATIONS WITH A PERTURBING FIELD. L.C.Allen.
Phys. Rev., Vol. 118, No. 1, 167-75 (April 1, 1960).

The Hartree–Fock equations under the action of an arbitrary field for any order of perturbation are set up in an integro-differential form. This form appears particularly advantageous for practical computation in such problems as electronic polarizability and electronic structure perturbations caused by nuclear moments. The equations are explicitly written down for a uniform perturbing field and a comparison is made with previous formulations. A wide variety of other applications is also discussed.

539.18

9735 CALCULATION OF POLARIZABILITIES. II. DEPENDENCE OF THE POLARIZABILITY ON THE ATOMIC VOLUME. P.Gombás.
Acta phys. Hungar., Vol. 11, No. 2, 201-3 (1960). In German.

The formulae described in Pt I (Abstr. 13723 of 1959) are applied to the case of argon atoms. It is found that the Clausius–Mosotti law is approximately satisfied. W.A.Hepner

539.18

9736 THE POLARIZABILITIES OF ATOMS FROM BORON TO NEON. A.Dalgarno and D.Parkinson.
Proc. Roy. Soc. A, Vol. 250, 422-6 (March 24, 1959).

The dipole polarizabilities of boron, carbon, nitrogen, oxygen, fluorine and neon are calculated using a theory based upon an antisymmetrized Hartree approximation. The results are in satisfactory agreement with available experimental data.

539.18

9737 IRON SERIES HARTREE–FOCK CALCULATIONS. R.E.Watson.
Phys. Rev., Vol. 118, No. 4, 1036-45 (May 15, 1960).

Seventy-six Hartree–Fock calculations have been completed for the iron series (Sc to Cu) atoms and ions. All calculations are for the $(3d)^n$ type of configuration (i.e., no 4s electrons are present). The results are discussed but, due to lack of space, are not presented. Comparisons are made with the experimental ionization and multiplet spectra. Agreement is poor due to limitations in the Hartree–Fock formalism. The results are used in an effort to gain information concerning correlation energies.

539.18 : 539.16

9738 A STUDY OF THE EXCITATION AND AUTO-IONIZATION OF AN ELECTRON CLOUD ACCOMPANYING THE K-CAPTURE OF Ge^{71}. M.Langevin.
J. Phys. Radium, Vol. 19, No. 1, 34-5 (Jan., 1958). In French.

The proportional counter study of the probability of the production of a double vacancy in the K shell during K capture of Ge^{71} gives the value $P(2) = (1.33 \pm 0.15)\ 10^{-4}$, the partial probability of autoionization being $P(\text{eject.}) = (0.78 \pm 0.07)\ 10^{-4}$. These experimental results are in good agreement with the theory of Primakoff and Porter (Abstr. 3559 of 1953).

539.18 : 537.56

ELECTRON CAPTURE BY TRIPLY CHARGED Ne^{3+} AND Kr^{3+} IONS IN NEON AND KRYPTON. See Abstr 8998

539.18

9739 THE CORRELATION ENERGIES OF THE HELIUM SEQUENCE. A.Dalgarno.
Proc. Phys. Soc., Vol. 75, Pt 3, 439-40 (March, 1960).

The coefficients in the expansion of the Hartree–Fock energy of a helium-like ion in inverse powers of Z can be found exactly by solving a set of differential equations, each corresponding to a different order of perturbation. The leading term in this expansion is calculated, and confirms Löwdin's estimate (Abstr. 4292 of 1959).
J.Hawgood

539.18

9740 THE RELATIVISTIC AND RADIATIVE CORRECTIONS TO THE EIGENVALUES OF THE HELIUM SEQUENCE. A.Dalgarno and A.L.Stewart.
Proc. Phys. Soc., Vol. 75, Pt 3, 441-4 (March, 1960).

The methods of Abstr. 8760 of 1957 and 13730 of 1959 are applied to obtain exact values of the relativistic correction to $O(Z^5\alpha^2)$ and of the radiative correction to $O(Z^3\alpha^3)$ for the ground-state ionization potential of a helium-like ion.
J.Hawgood

539.18

9741 RELATIVISTIC SELF-CONSISTENT SOLUTIONS FOR ATOMS OF LARGE ATOMIC NUMBER. S.Cohen.
Phys. Rev., Vol. 118, No. 2, 489-94 (April 15, 1960).

Relativistic self-consistent solutions, without exchange, have been obtained for several atoms of large atomic number by use of a general programme for a high speed computing machine. A short description of this programme and of the self-consistent calculation is given. Eigenvalues for the individual electron subshells of the self-consistent mercury, tungsten, platinum, and uranium atoms are presented. A comparison of the calculation with previous results for the mercury atom is also included.

539.18

9742 CALCULATION OF THE ELECTRON DENSITY OF THE Hg^{2+} ION ON THE BASIS OF A GENERALIZED STATISTICAL MODEL. P.Gombás and K.Ladányi.
Acta phys. Hungar., Vol. 7, No. 2, 255-61 (1957). In German.

The electron distribution in Hg^{2+} is determined using the statistical model of the atom (Abstr. 1519 of 1957), in which the electrons are grouped in accordance with the principal quantum number.
F.Lachman

539.18

9743 LIGHT BEATS AS INDICATORS OF STRUCTURE IN ATOMIC ENERGY LEVELS. J.N.Dodd, W.N.Fox, G.W.Series and M.J.Taylor.
Proc. Phys. Soc., Vol. 74, Pt 6, 789-91 (Dec., 1959).

Light beats at the frequency of an oscillatory field designed to induce transitions between a pair of excited eigenstates have been observed in the decay of the 6^3P_1 level in mercury. Investigation of the relationship between the amplitude of the beats and the cross products of the excited state suggest that the beats are a consequence of coherence between the original eigenstates.
R.A.Ballinger

539.18

9744 MAGNETIC HYPERFINE STRUCTURE OF THE GROUND STATE OF LITHIUM. R.K.Nesbet.
Phys. Rev., Vol. 118, No. 3, 681-3 (May 1, 1960).

The magnetic hyperfine splitting of the ^2S ground state of the lithium atom is calculated. It is shown that the discrepancy between experiment and the value calculated in the traditional Hartree–Fock approximation can be accounted for quantitatively by the exchange polarization effect, which distorts one 1s orbital relative to the other. The present calculation obtains a value within 1% of the experimental value. A general procedure is proposed for evaluating operators that do not commute with the Hamiltonian, when approximate variational methods must be used.

539.18

9745 THE DEPENDENCE OF THE ELECTRON-AFFINITY OF FREE ATOMS ON THE ATOMIC NUMBER. P.Gombás and K.Ladányi.
Z. Phys., Vol. 158, No. 3, 261-7 (1960). In German.

Using a modified statistical model of the atom, the electron-affinity of the elements P, S, Cl and A are calculated. It is found, in excellent agreement with experience, that the affinity rises in this series to its maximum, reached in the case of Cl, and that it becomes zero for A.
P.Roman

539.18

9746 THE RADIAL CHARGE DENSITIES FOR THE Ti^{+2} ARGON CORE. D.R.Hartree.
Proc. Cambridge Phil. Soc., Vol. 56, Pt 2, 174-5 (1960).

These were obtained from estimated self-consistent field wave functions.
J.Hawgood

539.18

9747 CALCULATION OF IONIZATION ENERGIES. P.Gombás and K.Ladányi.
Acta phys. Hungar., Vol. 8, No. 3, 301-3 (1958). In German.

In a previous paper (Abstr. 1519 of 1957) the authors worked out a statistical model of the atom. The results are now applied to the calculation of the ionization excitation energy of the argon atom. Comparison with values obtained empirically shows moderate agreement.
A.E.I.Research Laboratory

539.18

9748 A METHOD OF SPECTRAL ISOTOPIC ANALYSIS OF LITHIUM. F.F.Gavrilov.
Optika i Spektrosk., Vol. 7, No. 3, 285-8 (Sept., 1959). In Russian.

The isotopic composition of lithium was determined from the components of the Li I line at 6707.86 A under conditions ensuring practical absence of reabsorption in the light source. The isotopic structure was resolved by means of a Fabry–Perot etalon crossed with a diffraction spectrograph. The absolute error in determination of Li^6 at concentrations from 7.5 to 90% amounted to only 0.2%. The relative abundance in naturally occurring lithium was found to be given by $Li^7/Li^6 = 12.2 \pm 0.3$.
A.Tybulewicz

539.18

9749 EFFECT OF TEMPERATURE ON THE VARIATION OF THE ISOTOPIC COMPOSITION OF LIQUID MERCURY IN THE ELECTRIC FIELD OF A CONSTANT CURRENT. I.V.Bogoyavienski, V.N.Grigoriev and N.S.Rudenko.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1241-6 (Nov., 1959). In Russian.

An experimental study was made of the temperature dependence of the change in the concentration of liquid mercury isotopes upon passage of a constant electric current through the liquid. In the stationary case the change in the concentrations was found to be independent of temperature. Some possible mechanisms of the phenomenon are discussed.

539.18

9750 A QUALITATIVE INTERPRETATION OF THE MEAN ELECTRON EXCITATION ENERGY IN ATOMIC COLLISIONS. O.B.Firsov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1517-23 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1076-80 (Nov., 1959).

The transformation of the kinetic energy of the relative motion of colliding particles into the excitation energy of electrons is interpreted as resulting from their deceleration caused by an electron exchange. The motion of electrons in the region of overlapping shells of the colliding particles is considered quasi-classically. It is assumed that, when the electron moves out of the potential field of one of the atoms into that of another, it transfers from the first atom to the second a momentum which, on the average, is equal to the product of the relative velocity of the atoms and the mass of the electrons.

539.18 : 539.12

9751 INELASTIC COLLISIONS BETWEEN FAST POLARIZED PARTICLES AND ATOMS. V.V.Batygin and I.N.Toptygin.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1372-8 (Nov., 1959). In Russian.

The differential cross-section for scattering of electrons, positrons and μ-mesons on atoms was derived in the Born approximation as a function of the polarization of the particles in the initial and final states. The change in the polarization vector which occurs when the particles are scattered on free electrons was also determined.

539.18

9752 ELECTRON–HYDROGEN SCATTERING AT LOW ENERGIES. T.Ohmura and H.Ohmura.
Phys. Rev., Vol. 118, No. 1, 154-7 (April 1, 1960).

The effective range in the singlet electron–hydrogen system has been evaluated as 2.646 ± 0.004 atomic units by using the asymptotic

amplitude of the 202-parameter H^- wave-function of Pekeris (Abstr. 2860 of 1959). This value of the effective range, together with the value of the electron affinity of H^-, determines the scattering length in the singlet system as 6.167 atomic units. The effective range in the triplet system is calculated to be 1.219 atomic units by a Hartree–Fock approximation. It is shown that the effective-range approximation is very good for all energies at which only elastic scattering is allowed. The photo-ionization of H^- is briefly discussed on the basis of the effective-range theory.

539.18 : 539.11

UPPER BOUND ON THE SINGLET ELECTRON–HYDROGEN SCATTERING LENGTH. See Abstr. 9288

539.18

9753 THE ELASTIC SCATTERING OF FAST ELECTRONS AND POSITRONS BY HYDROGEN AND HELIUM ATOMS.

B.L.Moiseiwitsch and A.Williams.

Proc. Roy. Soc. A, Vol. 250, 337-45 (March 24, 1959).

A simplification of the second Born approximation due to Massey and Mohr (1934) is used to calculate the differential cross-sections for the elastic scattering of fast electrons and fast positrons by hydrogen atoms and helium atoms, the method of Dalitz being applied to evaluate all the relevant integrals. Although the logarithmic singularity which is found in the differential cross-section for zero-angle scattering is shown to be absent in the true second Born approximation the use of the simplification of this approximation is justified at sufficiently high impact energies provided the angle of scattering is not too small. The results of the calculations for incident electrons in helium are compared with the available experimental data.

539.18 : 539.2 : 548.7

ATOMIC SCATTERING FACTOR FOR O^{2-}. See Abstr. 8197

539.18 : 548.7 : 539.2

COMPTON INCOHERENT SCATTERING FUNCTIONS OF Li, Li^+, Be, Na, Na^+, Al, Al^{3+}, K^+, Cl^-, Ca, Ca^+, Ca^{2+}. See Abstr. 8196

539.18

9754 LONG RANGE FORCES BETWEEN ATOMS.

H.L.Kyle and E.Merzbacher.

Proc. Phys. Soc., Vol. 75, Pt 1, 164-5 (Jan., 1960).

Describes an improvement to Unsöld's (1927) approximation for evaluating the second-order perturbation energy, consisting in using the exact value of the most important term(s) with Unsöld's approximation E_0–E_m= constant for the others. Testing the method against the exact results of Dalgarno and Lewis (Abstr. 2336, 3131 of 1956) shows the improvement to be appreciable.

J.Hawgood

539.18

9755 LOW ENERGY STOPPING POWER OF ATOMIC HYDROGEN. A.Dalgarno.

Proc. Phys. Soc., Vol. 75, Pt 3, 374-7 (March, 1960).

The stopping powers of atomic hydrogen towards beams of protons, neutral hydrogen atoms and negative hydrogen ions are computed for beam energies up to 100 eV.

539.18

9756 THE REPULSIVE POTENTIAL BETWEEN TWO NORMAL HELIUM ATOMS. S.Huzinaga.

Progr. theor. Phys., Vol. 18, No. 2, 139-53 (Aug., 1957).

The repulsive potential between two normal helium atoms is calculated using the LCAO MO method. Two different effective charges for σ_g and σ_u orbitals are used and the restriction of a common charge for the both orbitals is removed. It is found that remarkable improvements are achieved for the theoretical calculation but there still remains a large discrepancy between theory and experiment. A critical discussion of the present status of theoretical calculations is attempted in some detail.

539.18 : 539.19

INTERACTIONS OF MU-MESIC HYDROGEN ATOMS. See Abstr. 7828

539.18

9757 WORKS ON ATOMIC SPECTROSCOPY IN THE U.S.S.R.

S.E.Frisch.

J. Opt. Soc. Amer., Vol. 50, No. 4, 400-4 (April, 1960).

Paper presented at Joint Commission for Spectroscopy Meeting, Moscow, Aug., 1958. Short descriptions are given, with extensive references, of the following subjects being actively pursued in the U.S.S.R. at the present time: (1) the determination of relative and absolute f-values in particular for Al, Tl, Mo, Ti, V, Cr, Mn, Fe, Co, Ni, Ba^+, Ca^+, Sr^+, by the hook method of Rogestwensky and from anomalous dispersion measurements. Results for thallium show that the sum-rule is not obeyed; (2) the presence of secondary maxima near the excitation potentials, in the study of collision cross-sections, have been discovered and a theory developed to explain this effect; (3) nuclear moments have been obtained from studies of the h.f.s. of spectral lines, in particular for U, Pu, Ce, Pr, Ho and Dy, and for the green Hg lines, in which the presence of Hg^{199} has been demonstrated in Au^{198} bombarded with neutrons; (4) investigations of luminous discharges, correlating electrical and spectral characteristics, have been made, showing that in general the Boltzmann–Saha equations are true, although deviations from thermodynamic equilibrium have been considered. A non-stationary theory has been developed to relate line-widths to line-shifts due to impact-broadening; and a method has been found for making "hook" measurements in times as short as 1 μsec; (5) the length of the metre has been determined in terms of the red cadmium line, the result obtained, λ = 6438.4687 A, is however in conflict with that adopted internationally; (6) the physical basis of spectrochemical analysis has been reexamined and the validity of the use of "curves of growth" in astrophysics demonstrated.

P.A.Young

539.18

9758 ON THE ORIGIN OF THE UNDERLYING CONTINUA APPEARING IN THE SPECTRA OF THE LIGHT EMITTED BY CONDENSED DISCHARGES THROUGH RARE GASES.

F.Gans.

C.R. Acad. Sci. (Paris), Vol. 250, No. 11, 2004-6 (March 14, 1960). In French.

Nedelsky's model (Abstr. 1021 of 1933) has been used successfully to account for the variation with excitation conditions of the spectral intensity distributions of the continua (Abstr. 5056 of 1960).

R.W.Nicholls

539.18

9759 EFFECTIVE EXCITATION CROSS-SECTIONS OF CERTAIN SPECTRAL LINES OF ARGON.

L.M.Volkova and A.M.Devyatov.

Optika i Spektrosk., Vol. 7, No. 6, 819-20 (Dec., 1959). In Russian.

Reports measurements of the effective electron-beam excitation cross-sections for the following lines of argon: 7514.6, 7948.2, 8006-8014.8, 8115.3, 8264.5, 8408.2 and 8424.6 A. These cross-sections ranged from 3 to 25 × 10^{-19} cm^2 at electron energies from 18 to 30 eV.

A.Tybulewicz

539.18

9760 EFFECT OF SPECTROMETER WINDOW ON THE K ABSORPTION EDGE OF Au.

O.Beckman, B.Axelsson and P.Bergvall.

Ark. Fys., Vol. 15, Paper 41, 567-78 (1959).

An X-ray determination of the K absorption edge of Au with a spectral resolution of 0.1% and with use of different absorber thicknesses is reported. A shift of the edge towards shorter wavelengths for increased absorber thickness of 0.020 XU per 0.1 mm absorber is found. Extrapolation to zero thickness gives Au K: 153.275 ± 0.010 XU, or 80.7205 ± 0.005 keV. The Au Kα emission lines are measured and the corresponding L level energies obtained by other investigators are added: Au $K\alpha_1$ + L_{III}: 80.7254 ± 0.0023 keV, Au $K\alpha_2$ + L_{II}: 80.7251 ± 0.0022 keV. The size of the shift is theoretically accounted for with certain assumptions on the spectrometer window.

539.18

9761 THE ABSORPTION SPECTRUM OF CALCIUM VAPOUR IN THE VACUUM ULTRA-VIOLET. T.R.Kaiser.

Proc. Phys. Soc., Vol. 75, Pt 1, 152-3 (Jan., 1960).

The spectrum between 2000 and 1500 A contains a continuum and two series of line spectra, one being "broad" and the other "narrow". A discussion of the possible identifications of these series is given together with the constants of the Rydberg–Ritz formula for the identification chosen.

G.H.C.Freeman

539.18

9762 THE THIRD SPECTRUM OF COBALT (Co III). A.G.Shenstone.

Canad. J. Phys., Vol. 38, No. 5, 677-92 (May, 1960).

A nearly complete analysis of the third spectrum of Co (Co III) is given, based chiefly on observations in the vacuum ultraviolet region. The chief structures found are $3d^7$, $3d^6$ 4s, $3d^6$ 4p, and $3d^6$ 4d. The last of these is not commonly found in third spectra and it is here very incomplete. Some cases of unusual intensities in intersystem combinations are pointed out, especially ones in which the intensity in the combinations with the central of three J values is zero or very small. The complete line list is given.

539.18

9763 DEPARTURES FROM THE SAHA EQUATION UNDER VARYING CONDITIONS OF LYMAN CONTINUOUS OPACITY. S.R.Pottasch and R.N.Thomas.

Astrophys. J., Vol. 130, No. 3, 941-53 (Nov., 1959).

A general method for determining the departure from the Saha equation in a hydrogen atmosphere is presented. The usually stated, vague condition of "high opacity in the Lyman continuum" is not sufficient to insure LTE; departures from LTE may amount to several orders of magnitude even under this condition. For illustration, application of the method is made to an atmosphere of constant T_e and n_e, and to an approximate chromospheric model.

539.18

9764 EFFECT OF IMPURITIES ON THE X-RAY EMISSION SPECTRA OF TRANSITION METALS. I.B.Borovskii and K.P.Gurov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1203-6 (April, 1959). In Russian. English translation in: Soviet Physics – JETP (New York), Vol. 36(9), No. 4, 856-8 (Oct., 1959).

A method is proposed to estimate the effect of impurities on the parameters the spectra. The method is applied to the case of dilute alpha-solid solutions with iron as the base.

539.18

9765 THE ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. W.E.Mitchell,Jr.

Astrophys. J., Vol. 130, No. 3, 872-80 (Nov., 1959).

The tables calculated by Chandrasekhar and Breen have been interpolated and are presented in detail, from λ5000 to λ25 000 with $\Delta\lambda$ = 200 A and from θ = 0.70 to 1.50 with $\Delta\theta$ = 0.02.

539.18

9766 STUDY OF THE LEVELS OF He^3 BY OPTICAL SPECTROSCOPY AT VERY LOW TEMPERATURE. J.Brochard, H.Chantrel and P.Jacquinot.

J. Phys. Radium, Vol. 19, No. 5, 515-22 (May, 1958). In French.

The hyperfine structure of He^3 and the isotope shift $\Delta T(He^3-He^4)$ in the lines 7065, 4713, 4471 and 3888 A have been measured using a double Fabry–Perot etalon spectrophotometer and a hollow cathode usually cooled by liquid helium below the λ-point (~1.8° K). This work follows recent experiments on the fine structure of He^4 (see Abstr. 7694 of 1960).

539.18 : 537.52

9767 HELIUM LEVEL POPULATIONS IN A GLOW DISCHARGE. W.J.Condell, Jr.

J. Opt. Soc. Amer., Vol. 50, No. 6, 610-16 (June, 1960).

Spectral line intensities of a helium glow, discharge plasma were measured, and relative populations of the excited levels were calculated for various pressures from 0.842 to 2.83 mm Hg and currents from 3 to 40 mA.

539.18 : 621.327.53

9768 INTENSITIES OF λ1850 AND λ2537 IN LOW-PRESSURE MERCURY VAPOR LAMPS WITH RARE GAS PRESENT. B.T.Barnes.

J. appl. Phys., Vol. 31, No. 5, 852-4 (May, 1960).

The radiant flux in the Hg resonance lines just inside the wall of a lamp with an inside diameter of 35-36 mm is given for currents 0.4-2.0 A and various bulb temperatures and rare gas fillings. The intensity of the 1850 line ranges from 12 to 34% of that of the 2537 one, with the highest ratios occurring when both arc current and bulb temperature are at the upper end of the ranges used. Since this result is contrary to what one would expect with single-state excitation of the 1850 line, one must assume that this line is excited mainly by $6^3P-6^1P_1$ transitions when arc current and mercury vapour pressure are both relatively high. A rough estimate of the frequency of $6^3P_2-6^1P_1$ transitions, compared to those from the ground level to 6^1P_1 confirms this conclusion.

539.18

9769 ROTATIONAL ANALYSIS OF THE RED ABSORPTION BAND OF THE IBr MOLECULE. L.E.Selin.

Naturwissenschaften, Vol. 47, No. 5, 104-5 (1960). In German.

The band is observed at high dispersion and the molecular constants calculated from the observations are tabulated.

G.F.Lothian

539.18

9770 THE ABSORPTION SPECTRUM OF NEON. R.W.Ditchburn.

Proc. Phys. Soc., Vol. 75, Pt 3, 461-2 (March, 1960).

The absorption curve, between 600 and 220 A, is compared with that obtained by Po Lee and Weissler (Abstr. 1184 of 1955) and with theoretical curves calculated from dipole length and dipole velocity formulae.

G.H.C.Freeman

539.18

9771 THE SPECTRA OF RARE-EARTHS (AUGUST 1958). C.E.Moore.

J. Opt. Soc. Amer., Vol. 50, No. 4, 407-8 (April, 1960).

Paper presented at Joint Commission on Spectroscopy Meeting, Moscow, Aug., 1958. Summary tables, with descriptive notes and list of references, are given for the known data on the spectra of the rare-earths. A table is also given of terms arising from equivalent f-electrons.

P.A.Young

539.18

9772 PRESENT EXPERIMENTAL STATUS OF RARE-EARTH SPECTRA. W.F.Meggers.

J. Opt. Soc. Amer., Vol. 50, No. 4, 405-6 (April, 1960).

Paper presented at Joint Commission for Spectroscopy Meeting, Moscow, Aug., 1958. The experimental difficulties in connection with research on the lanthanides and actinides is pointed out, especially their chemical identity, the radioactivity of the latter, and the complexity of their spectra. How these have been overcome since 1950 is described and it is emphasized that it is now only the lack of interest and manpower devoted to these spectra, that delays the publication of Vol. IV of "Atomic Energy Levels" published by the National Bureau of Standards.

P.A.Young

539.18

9773 VECTOR COUPLING AND ROTATIONS IN THE RARE-EARTH SPECTRA. G.Racah.

J. Opt. Soc. Amer., Vol. 50, No. 4, 408-11 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, Moscow, August 1958. Points out, with illustrative examples, the importance of j–j and intermediate couplings to the analysis and description of rare-earth energy levels.

P.A.Young

539.18

9774 THE ISOTOPIC SHIFT BETWEEN THE STABLE Sr ISOTOPES AND THE Sr^{90} ISOTOPE AND THE DISCONTINUITY IN THE NUCLEAR VOLUME EFFECT AT THE NEUTRON NUMBER 50. K.Heilig and A.Steudel.

Naturwissenschaften, Vol. 47, No. 6, 129-30 (1960). In German.

The isotopic shift of the Sr isotopes 84, 86, 88 and 90 has been measured with a photoelectric Fabry–Perot spectrometer and the existence of a discontinuity in the nuclear volume effect demonstrated. A comparison of the magnitude of this discontinuity at N = 50, 82, and 126 is made.

S.J.St-Lorant

539.18

9775 RELATIVISTIC PHOTO-EFFECT IN THE L-SHELL. M.Gavrila.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 309-11 (Jan., 1960). In Russian.

Expressions for the total and differential cross-sections for the three L-shells have been obtained, including terms of order αZ and valid for light nuclei. At high energies the total cross-sections are much larger than the corresponding non-relativistic formulae indicate.

D.W.L.Sprung

539.16 : 537.534

ELECTRON EJECTION OF METASTABLE ATOMS ON METAL SURFACES. See Abstr. 8983

MOLECULES

539.19

9776 ATOMS AND RADICALS TRAPPED AT 4°K. C.M.Herzfeld.

Physica, Vol. 24, Supplement, S179 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Early studies by Vegard at Leiden of spectra emitted by solid N_2 under electron bombardment showed many unexplained features. Recent work at National Bureau of Standards has indicated the presence of trapped atoms and free radicals. Present studies include optical spectroscopy, X-ray diffraction, electron bombardment, kinetic studies, mass spectroscopy, calorimetry, and γ-irradiation. Results obtained so far indicate that between 0.01 and 1 mol % concentrations of trapped radicals can be obtained in various types of solid matrices. Emission spectra indicate the presence of trapped N and O atoms, and their perturbations by the neighbouring molecules in the solid have been investigated. Evidence for complicated coupling of atomic levels and molecular motions has been obtained from experiments with N^{15} isotopes.

539.19

9777 THE CALCULATION OF MOLECULAR WAVE-FUNCTIONS. R.Daudel.

Cahiers de Phys., Vol. 12, 85-91 (March, 1958). In French.

Summarizes the introductory talk to the International Colloquium on Wave Mechanics, held in Paris in 1957. A resumé is given of some of the newer methods of calculation and their application to the study of molecular structure and to chemical reactivity. W.J.Orville-Thomas

539.19 : 539.18

THE DENSITY MATRIX IN MANY-ELECTRON QUANTUM MECHANICS. See Abstr. 9728

539.19 : 539.2

CALCULATION OF FRANCK–CONDON INTEGRALS. See Abstr. 7873

539.19

9778 A SIMPLE PRESENTATION OF SOME GENERAL RESULTS IN QUANTUM CHEMISTRY. R.Daudel.

Cahiers de Phys., Vol. 13, 470-5 (Dec., 1959). In French.

A non-mathematical presentation is given for some of the principal results of quantum chemistry. Amongst the problems dealt with qualitatively are the structures of atoms and molecules; valence bond angles; localized and delocalized bonds. W.J.Orville-Thomas

539.19

9779 THE ATOMIZATION OF HYDROGEN ON TUNGSTEN. D.Brennan and P.C.Fletcher.

Proc. Roy. Soc.A, Vol. 250, 389-408 (March 24, 1959).

The dissociation of hydrogen at a tungsten filament has been studied in the temperature range 1200° to 1800°K and at pressures between 10^{-3} and 10^{-6} mm. The results obtained differ from those found in the literature and it is shown that this is because the surfaces employed by previous workers were contaminated, very probably by vapours derived from tap grease. At temperatures below 1400°K and at pressures exceeding 10^{-6} mm, the rate of atomization of hydrogen is given by the expression:

$$\nu_a \text{ (atoms cm}^{-2}\text{ sec}^{-1}) = 18 \times 10^{24}(P_{H_2}\text{ mm})^{\frac{1}{2}}\exp(52\,600/RT).$$

The theory of absolute reaction rates is applied to the two possible mechanisms, namely W – H + W → W + H and H_2 + W → W – H + H; under the conditions considered, equilibrium between adsorbed and gaseous hydrogen is maintained throughout the reaction. Reasons are given for rejecting the second mechanism, which was the one favoured in the past. From a consideration of both the atomization and recombination reactions, it is demonstrated that the first equation is applicable and, further, that the absorbed atoms have full translatory freedom on the surface at the temperature of reaction. The observation that molecular and atomic hydrogen leave the filament in their equilibrium ratio, as determined by the temperature of the filament and the pressure of hydrogen, is shown to be compatible only with this description of the reaction. At temperatures in the region of 1800°K, the rate of reaction ceases to be proportional to $\sqrt{P_H}$ at relatively high pressures and has become linearly dependent on P_{H_2} at pressures less than 10^{-4} mm. This behaviour is discussed quantitatively in terms similar to those employed for the low-temperature reaction, but now there no longer exists an equilibrium between adsorbed and gaseous hydrogen. A study of the atomization on surfaces exposed to oxygen indicated that the adsorbed oxygen layer is rapidly removed by exposure to hydrogen at 1200°K and that, thereafter, the dissociation proceeds at the same velocity as on a clean surface. The reaction on a carbided surface occurred at a rather slower rate than obtained with a clean surface, but the activation energy remained unaffected. The nature of the contamination responsible for the low activation energies of about 45 kcal/mole reported by previous workers has thus not been identified.

539.19

9780 ROTATIONAL TRANSITION IN MOLECULAR COLLISIONS. I. TRANSITION IN DIATOMIC MOLECULE—GENERAL DISCUSSIONS. K.Takayanagi.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 2, 65-86 (1959).

Rotational transitions in diatomic molecules on colliding with an atom are investigated. The starting point of the mathematical formulation is somewhat different from the one given by Curtiss and Adler, though the equivalence of the two approaches can be proved by a simple transformation of the wave-function. The validity of the distorted wave method in this problem is re-examined. It is shown that the method can be applied only at low temperatures. To see the importance of terms in the effective cross-section which are of higher order with respect to the magnitude of the perturbation potential, the semi-classical method (suggested previously in Abstr. 1080 of 1955) is applied to an example. It is shown that the higher order terms are essentially required to get a reasonable answer. Some wave-mechanical methods are also suggested for solving these strong coupling problems without losing their essential features.

539.19

9781 ROTATIONAL TRANSITION IN MOLECULAR COLLISIONS. II. ROTATIONAL TRANSITION IN H_2, D_2 AND HD. K.Takayanagi.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 2, 87-100 (1959).

The previous calculation (Abstr. 6393 of 1957) of the effective cross-section of the process $H_2(l' = 0) + H_2(l'') \rightarrow H_2(l = 2) + H_2(l'')$ is extended to the processes $H_2(l' = 1) + H_2(l'') \rightarrow H_2(l = 3) + H_2(l'')$, $H_2(l' = 2) + H_2(l'') \rightarrow H_2(l = 4) + H_2(l'')$, and similar processes in deuterium gas. l etc. are the angular momentum quantum numbers of the molecular rotation. The distorted wave method with the modified wave number approximation is used. Rotational transition in HD gas is also studied. It is found that the transition probability is much larger in the gas than in H_2 or in D_2, and the distorted wave method becomes invalid at temperatures higher than 200°K.

539.19

9782 VIBRATIONAL TRANSITION IN MOLECULAR COLLISION. III. A SHORT TABLE OF A FUNCTION USEFUL FOR CALCULATING THE VIBRATIONAL TRANSITION PROBABILITY. K.Takayanagi and Y.Miyamoto.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 2, 101-14 (1959).

Assuming that the matrix elements of the intermolecular potential V with respect to the vibrational states, n, m of colliding molecules are $V_{nn} = V_{mm} = C\exp(-\alpha R) - \epsilon$, $V_{mn} = C_{mn}\exp(-\alpha R)$, R being the intermolecular distance, the effective cross-section of inelastic process $n \rightarrow m$ is given by

$$\bar{Q} = \pi R_0^2 \left|\Lambda_{mn}\right|^2 \Omega(\Delta q^2, T^*, \delta)$$

The distorted wave method with modified wave number approximation has been used in deriving this formula, where R_0 is a distance of the order of magnitude of the closest approach in the classical head-on collision, $\Lambda_{mn} = C_{mn}/C$, $\Delta q^2 = 8M\Delta E/\alpha^2$, $T^* = 4MkT/\alpha^2$, $\delta = (8M\epsilon/\alpha^2)^{1/2}$, M the reduced mass, k the Boltzmann constant and ΔE the energy transferred to the translational motion in the process. Values of Ω are shown in the form of numerical tables as well as graphically. In an appendix, the semiclassical theory of vibrational transition given by Zener in 1932 for the one-dimensional collision is extended to the three-dimensional collision.

539.19

9783 THE ASYMMETRIC ROTATOR IN QUANTUM MECHANICS AND ROTATIONAL EIGENFUNCTIONS FOR THE WATER MOLECULE. P.G.Khubchandani and A.Rahman.
Ann. Soc. Sci. Bruxelles I, Vol. 74, No. 1, 35-57 (1960).

Gives an account of the expansion of the eigenfunctions of the asymmetric rotator in terms of the functions $D^J_{m\,k}$ which occur in the symmetric case, and the application of this theory to the water molecule, of which the eigenvalues and eigenfunctions are tabulated for $J = 0$ to $J = 12$. J.Hawgood

539.19

9784 ASYMMETRIC ROTOR ENERGY LEVELS: AN IMPROVED COMPUTATIONAL PROCEDURE.
J.M.Bennett, I.G.Ross and E.J.Wells.
J. molecular Spectrosc., Vol. 4, No. 4, 342-8 (April, 1960).

The quotient-difference algorithm of Rutishauser [Appl. Math. Ser. Nat. Bur. Stand., No. 49, 47 (1958)] has been advantageously applied to the calculation of asymmetric rotor energies.

539.19

9785 GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE n-FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. I. THE TWOFOLD DEGENERATE OSCILLATOR.
J.D.Louck and W.H.Shaffer.
J. molecular Spectrosc., Vol. 4, No. 4, 285-97 (April, 1960).

An operational procedure is used to determine the eigenvalues and eigenfunctions for the quantum-mechanical twofold degenerate oscillator problem in polar coordinates. The procedure leads automatically to the determination of the nonvanishing matrix elements of the Cartesian coordinates and conjugate linear momenta of the oscillator.

539.19

9786 GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE n-FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. II. THE n-FOLD DEGENERATE OSCILLATOR.
J.D.Louck.
J. molecular Spectrosc., Vol. 4, No. 4, 298-333 (April, 1960).

A set of commuting generalized orbital angular momentum operators in n-dimensional polar coordinates is defined and their eigenvalues and simultaneous eigenfunctions determined by the use of results known from the factorization method of solving eigenvalue problems. A set of generalized orbital angular momentum components is also defined and relations are given for determining their nonvanishing matrix elements. The n-fold degenerate oscillator radial equation is solved by a quadrupole factorization of the Hamiltonian and these radial equation results are combined with the generalized angular momentum results to obtain relations from which the nonvanishing matrix elements of the Cartesian coordinates and conjugate linear momenta of the oscillator can be calculated.

539.19

9787 GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE n-FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. III. RADIAL INTEGRALS. J.D.Louck.
J. molecular Spectrosc., Vol. 4, No. 4, 334-41 (April, 1960).

The hydrogen-atom radial equation is solved by transforming it to a twofold degenerate oscillator radial equation, and the explicit relation between the hydrogen-atom and oscillator radial functions is written out. This relation can be used to evaluate various two-dimensional oscillator radial integrals from known hydrogen-atom radial integrals or vice versa. Also, an identity is derived between two types of radial integrals involving the hydrogen-atom radial functions or the n-fold degenerate oscillator radial functions.

539.19

9788 RELATIONSHIPS BETWEEN VIBRATIONAL FREQUENCIES OF ISOTOPIC MOLECULES (THE SUM AND PRODUCT–SUM RULES FOR POWERS OF THE SQUARES OF FREQUENCIES). L.M.Sverdlov.
Optika i Spektrosk., Vol. 8, No. 1, 36-9 (Jan., 1960). In Russian.

Earlier the author deduced a relationship between the sums of the products of the squares of vibrational frequencies of isotopic molecules, the squares being taken two, three, etc., at a time. The present paper extends this to powers of the frequencies squared. A.Tybulewicz

539.19

9789 VIBRATIONAL RELAXATION IN GASES.
J.D.Lambert and R.Salter.
Proc. Roy. Soc. A, Vol. 253, 277-88 (Nov. 24, 1959).

The velocity of ultrasonic waves was measured in a number of gases at 25° C and for values of the ratio, ultrasonic frequency/pressure, ranging from 2×10^6 to 2×10^7 c s^{-1} atm^{-1}. Dispersion, corresponding to a single vibrational relaxation process was shown by acetylene, CD_3Br and Hexafluoro-ethane; and, to a double relaxation process, by ethane. Incipient dispersion was shown by propane, ethyl chloride, ethyl fluoride and dimethyl ether. No dispersion was shown by 1 : 1-difluoro-ethane, n-butane, iso-butane, neopentane and ammonia. Correlation of these with previous results leads to the conclusion that: (a) for molecules with a distribution of fundamental frequencies, such that there is only a small gap between the lowest and the remaining frequencies, vibrational activation enters via the lowest mode and spreads rapidly to the other modes, giving rise to a single relaxation process involving the whole of the vibrational energy. The chief factors determining the probability of excitation of the lowest mode are its frequency and the presence or absence of hydrogen atoms in the molecule. Molecules containing two or more hydrogen atoms suffer translational–vibrational energy transfer very much more easily than other molecules. Deuterium has almost the same effect as hydrogen. (b) For molecules in which there is a large gap between the lowest and the remaining fundamental frequencies, a double relaxation process occurrs. The complex energy transfer probabilities involved do not fit the same quantitative functional relation with vibrational frequency as in (a) above. (c) Torsional oscillations due to hindered internal rotation behave similarly to other fundamental modes. For molecules in which there is a large gap between the torsional frequency and the other modes (e.g. ethane) a double relaxation process occurs as in (b). Where there is no such gap, vibrational energy enters all modes via the torsional mode as in (a).

539.19

9790 THE BAND CONTOURS OF FORCED ROTATIONAL AND VIBRATIONAL SPECTRA OF NON-POLAR MOLECULES. E.E.Nikitin.
Optika i Spektrosk., Vol. 7, No. 6, 744-50 (Dec., 1959). In Russian.

A quasi-classical approximation is used to calculate the form and the half-width of the forced rotational and vibrational absorption bands (due to the collision-induced dipole moments) of non-polar molecules undergoing double collisions. The theoretical and experimental half-widths of the bands due to collisions of hydrogen with various molecules and atoms agree satisfactorily. The analogy between the spectra of forced absorption or emission and the electron absorption or luminescence spectra of complex molecules is dealt with briefly. A.Tybulewicz

539.19

9791 THE ABSORPTION OF LIGHT AND LUMINESCENCE OF COMPLEX MOLECULES. S.I.Kubarev.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 5, 1067-70 (Feb. 11, 1960). In Russian.

The infrared properties of complex molecules are examined by means of an adiabatic approach. This is made possible by dealing with the infrared spectrum of discrete molecules and assuming that the long-wavelength bands may be isolated from the remainder of the spectrum. K.N.R.Taylor

539.19

9792 CLASSICAL THEORY OF ALKALI HALIDE MOLECULES. Y.P.Varshni.
Trans Faraday Soc., Vol. 53, Pt 2, 132-7 (Feb., 1957).

Calculations of rotational constant α_e and vibrational constant $\omega_e\chi_e$ for alkali halide molecules have been carried out assuming two types of repulsion terms in the potential energy function, viz. inverse power and exponential. By comparing the calculated values of α_e and $\omega_e\chi_e$ with the observed ones it has been concluded that the exponential type of repulsion term is satisfactory.

539.19 : 539.2 : 548.7

MOLECULAR VIBRATIONS OF DI-p-XYLYLENE.
See Abstr. 8248

539.19

9793 REGULARITIES IN THE ABSORPTION OF INFRARED RADIATION IN THIN LAYERS OF CERTAIN GASES. I. THE ABSORPTION COEFFICIENT IN VIBRATION–ROTATIONAL BANDS. P.I.Bresler.

Optika i Spektrosk., Vol. 7, No. 5, 608-15 (Nov., 1959). In Russian.

General relationships are deduced for absorption in thin layers of gases consisting of molecules whose vibration–rotational bands may be represented by comparatively simple models. Approximate expressions are given for the absorption coefficient and absorbed radiation flux in vibrational–rotational bands of diatomic and more complex molecules. The absorption coefficient is deduced also for the special case of positions far from the band centre; the limits of the rotational structure and the absorption coefficient within those limits are given. The experimental data on the rotational structure of HCl and CO_2 bands agree satisfactorily with the calculated values.

A.Tybulewicz

539.19

9794 REGULARITIES IN THE ABSORPTION OF INFRARED RADIATION IN THIN LAYERS OF CERTAIN GASES. II. ABSORPTION OF RADIATION IN VIBRATION–ROTATIONAL BANDS OF CERTAIN GASES. P.I.Bresler.

Optika i Spektrosk., Vol. 7, No. 5, 616-20 (Nov., 1959). In Russian.

Formulae are derived which relate radiation flux absorbed in a comparatively thin layer of a gas to the parameters of an appropriate vibrational–rotational band. The limits of applicability of the linear and square-root laws of absorption are given. A.Tybulewicz

539.19

9795 PRESSURE BROADENING STUDIES ON VIBRATION–ROTATION BANDS. I. THE DETERMINATION OF LINE WIDTHS. D.R.Eaton and H.W.Thompson.

Proc. Roy. Soc. A, Vol. 251, 458-74 (June 23, 1959).

Methods for determining the true widths of lines in simple vibration–rotation bands are considered, and a procedure is devised for studying the effect of added gases upon the line widths in the fundamental vibration bands of deuterium chloride and carbon monoxide.

539.19

9796 PRESSURE BROADENING STUDIES ON VIBRATION–ROTATION BANDS. II. THE EFFECTIVE COLLISION DIAMETERS. D.R.Eaton and H.W.Thompson.

Proc. Roy. Soc. A, Vol. 251, 475-85 (June 23, 1959).

Using the methods described in Pt I, the line-widths in the fundamental vibration–rotation bands of deuterium chloride and carbon monoxide were measured, under conditions of self-broadening and also in the presence of added gases. The optical collision diameters were calculated and compared with the molecular diameters derived from viscosity data. An attempt is made to interpret the high effective collision diameters found in terms of intermolecular interactions of different types, and it is concluded that London dispersion forces, resonant dipole effects and quadrupole interactions may be important. The variation of line width in a band as a function of J quantum number has been measured and considered in terms of these interactions. The results suggest that further studies of this kind may throw additional light not only upon the nature of intermolecular forces but also upon the factors affecting energy transfer in collision.

539.19

9797 LINE STRENGTH MEASUREMENTS IN VIBRATION BANDS OF DEUTERIUM CYANIDE. D.R.Eaton.

Proc. Roy. Soc. A, Vol. 251, 486-92 (June 23, 1959).

The effect of vibration–rotation interaction upon line strengths in the fundamental vibration–rotation bands of deuterium cyanide was examined. The results appear to confirm an effect predicted by Gallop (Abstr. 3415 of 1958) which results in a weakening of lines in one branch of each band and a corresponding enhancement in the other branch. From the results it has been possible to determine the signs of the dipole derivatives with respect to symmetry coordinates and to clarify previous ambiguities about this.

539.19

9798 THE VIBRATION AND DECOMPOSITION OF THE HYDROGEN PEROXIDE MOLECULE.

E.K.Gill and K.J.Laidler.

Proc. Roy. Soc. A, Vol. 251, 66-75 (May 12, 1959).

A complete vibrational analysis is worked out for hydrogen peroxide, using the data of Giguère and Bain [J. phys. Chem., Vol. 56, 340 (1952)]. The FG matrix method of Howard and Wilson is employed, use being made of symmetry coordinates. The amplitude factors corresponding to each of the six normal modes of vibration are calculated. Slater's equation for the rate of energization of a molecule within which there can be no flow of energy between the normal modes is then employed to calculate rates, different choices of the critical reaction coordinate being made. The choice of the O–O distance as the critical coordinate leads to a rate of energization that is about 10^{-8} of the experimental value. The maximum possible rate predicted by the Slater equation is about 10^{-2} of the experimental value. The implications of these results are briefly discussed in terms of the hypothesis that there is a flow of energy between the normal modes of the molecule, as assumed in the treatments of Hinshelwood, Kassel, and Rice and Ramsperger.

539.19

9799 LOW TEMPERATURE INFRARED ABSORPTION SPECTRA OF ROCHELLE SALT (7000-9000 cm^{-1}) AND THE FUNDAMENTAL FREQUENCIES OF THE WATER MOLECULES. M.P.Bernard.

C.R. Acad. Sci. (Paris), Vol. 250, No. 10, 1830-2 (March 7, 1960). In French.

Spectra taken at −180°C using plane polarized radiation enable the fundamental frequencies ($\nu_1\nu_2\nu_3$) of the four water molecules of Rochelle salt (NaK $C_4H_4O_6.4H_2O$) to be calculated. The values obtained are : 3353, 1650 and 3537 cm^{-1}; 3275, 1650 and 3485 cm^{-1}; 3206, 1650 and 3413 cm^{-1}; 3049, 1650 and 3183 cm^{-1}, for the 1st, 2nd, 3rd and 4th molecules respectively. D.L.Greenaway

539.19

9800 ROTATIONAL ANALYSIS OF THE $A^1\Pi-X^1\Sigma$ SYSTEM OF SnO. A.Lagerqvist, N.E.L.Nilsson and K.Wigartz.

Ark. Fys., Vol. 15, Paper 38, 521-30 (1959).

Rotational analyses of the 1,0,0,0 and 0,1 bands of the A–X system of SnO have been carried out. The system corresponds to a $^1\Pi-^1\Sigma^+$ transition. Rotational constants for the upper and lower states have been derived. For the most abundant isotopic molecule $Sn^{120}O^{16}$ they are as follows: $B'_v = 0.3145_8 - 0.0025\ (v' + \frac{1}{2})\ cm^{-1}$; $r'_e = 1.950$ A. $D'_v = [0.39 + 0.02 \times v'] \times 10^{-6}\ cm^{-1}$; $B''_v = 0.3561 - 0.0022\ (v'' + \frac{1}{2})\ cm^{-1}$; $r''_e = 1.832$ A. $D''_v = 0.29 \times 10^{-6}\ cm^{-1}$; $\nu_e = 29624\ cm^{-1}$. Several perturbations have been found in the upper vibrational levels. One of the perturbing states is probably a $^4\Pi$ state. Lines of the molecules $Sn^{112}O^{16}$ and $Sn^{120}O^{18}$ in the 0,1 band have also been measured. The shifts give $\rho_{112} = 0.99802$ and $\rho^2_{118} = 0.99594$.

539.19

9801 THE VIBRATION FREQUENCY OF THE TlI MOLECULE. K.S.Krasnov.

Optika i Spektrosk., Vol. 7, No. 6, 843-4 (Dec., 1959). In Russian.

Two different frequencies of the same vibration of TlI have been reported: $\omega_e = 150\ cm^{-1}$ and $\omega_e \cong 120\ cm^{-1}$. The present note gives two physical arguments in favour of the first of these values.

A.Tybulewicz

539.19

9802 INFRARED SPECTRA OF ACETYLENE IN SOLUTION. J.Jacob.

C.R.Acad. Sci. (Paris), Vol. 250, No. 9, 1624-6 (Feb. 19, 1960). In French.

The spectrum of acetylene in the gaseous state is compared with the results obtained when dissolved in a series of organic solvents. The bands between 5000 and 750 cm^{-1} are tabulated. Large displacements observed for the antisymmetric ν_3 band indicate the formation of complexes between acetylene and some of the solvents.

D.L.Greenaway

539.19

9803 INFRARED ABSORPTION SPECTRA OF BENZENOCARBOXYLIC ACIDS. ASSIGNMENT OF VIBRATIONAL MODES TO THE RECORDED BANDS.

A.Hidalgo and F.Gonzalez-Sanchez.

J. Phys. Radium, Vol. 19, No. 5, 536-40 (May, 1958). In French.

Infrared absorption spectra of the twelve benzenocarboxylic acids have been recorded in the region from 5000 cm^{-1} (2 μ) to 400 cm^{-1} (25 μ). The substances were investigated in the solid state by the KBr pellet method. Through the use of the comparison method, an attempt has been made to relate several series of frequencies to particular vibrational modes. The spectra show the presence of a strong and complex association in all these acids.

539.19

9804 ATTEMPT AT INTERPRETATION OF THE INFLUENCE OF A NON-POLAR SOLVENT ON THE VIBRATIONAL FREQUENCY OF THE CARBONYL GROUP.

M.M.Bottreau, J.Gerbier and E.Gray.

J. Phys. Radium, Vol. 19, No. 5, 552-6 (May, 1958). In French.

Results previously obtained have shown that the vibrational frequency of the carbonyl group, about 1700 cm^{-1}, increases appreciably when the compound studied is diluted with a non-polar solvent. This increase can be regarded as the sum of a coupling effect between molecules and the "Kirkwood effect" relative to the frequency shift of an oscillator in terms of the dielectric constant of the medium. The respective share of these two effects has been shown by coupling the carbonyl group in a hydrogen-bonded complex that eliminates the coupling effect, and by studying the infrared spectra of this complex diluted with hexane. It seems that the "Kirkwood effect" is often predominant.

539.19

9805 SOLVENT EFFECT ON THE INFRARED ABSORPTIONS OF N-METHYLACETAMIDE IN THE REGION OF THE NH STRETCHING FREQUENCY.

I.Suzuki, M.Tsuboi and T.Shimanouchi.

J. chem. Phys., Vol. 32, No. 4, 1263-4 (April, 1960).

Reports absorption measurements of N-methylacetamide dissolved in ten solvents containing phenyl groups. Spectra between 3400 and 3500 cm^{-1} (the free NH stretching region) show that the absorption maximum of the NH group depends on the π-electron density in the phenyl group of the solvent molecule. The presence of a weak NH sub-band is also established. D.L.Greenaway

539.19

9806 ABSORPTION FREQUENCIES OF NEGATIVE HYDROGEN MOLECULE IONS BETWEEN 2.5 AND 44 Mc/s.

T.V.Ionescu and O.C.Gheorghiu.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2182-4 (March 21, 1960). In French.

Ions were produced by a discharge at potentials up to 5 kV, in pure hydrogen and in hydrogen mixed with neon or mercury vapour, at total pressures near 10^{-3} mm. Radiofrequency absorptions were detected (see Abstr. 123 of 1958) and discussed in relation to experimental conditions. It is suggested that a given discharge-voltage results in destruction of all negative ions for which the rotational quantum number k is less than a fixed value. J.Sheridan

539.19

9807 THE MICROWAVE SPECTRUM OF METHANOL BETWEEN 9 AND 16 kMc/s, OBTAINED WITH A CARCINOTRON AS RADIATION SOURCE.

H.D.Rudolph, H.Dreizler and W.Maier.

Z.Naturforsch., Vol. 15a, No. 3, 273-4 (March, 1960). In German.

Fifteen new absorption lines have been accurately measured, and assignments made for seven of them in accordance with existing data and theory. Coefficients in the equation for Stark effect are given for two of the lines for which this effect is chiefly linear. Two other lines of this type are classified as a K-doublet. Some advantages and limitations of a carcinotron as a radiation source are pointed out. J.Sheridan

539.19

9808 STARK EFFECT AND DIPOLE MOMENT OF CH_3CH_2F.

G.H.Kwei and D.R.Herschbach.

J. chem. Phys., Vol. 32, No. 4, 1270-1 (April, 1960).

Stark effects for the M = 1, J = 1 → 2 transitions show large deviations from quadratic field-dependence, due to Stark perturbation terms connecting pairs of nearly degenerate levels. The data are accounted for by an extension of the treatment of Golden and Wilson (Abstr. 2638 of 1949). The dipole moment components derived independently from the M = 1 and M = 0 transitions are in agreement, and correspond to a total moment of 2.30 ± 0.03 D at an angle of 46.3° with the C-C bond. This agrees closely with a prediction based on bond-moments and polarizabilities.

J.Sheridan

539.19

9809 RECENT DEVELOPMENT OF MOLECULAR SPECTROSCOPY IN THE U.S.S.R. B.S.Neporent.

J. Opt. Soc. Amer., Vol. 50, No. 4, 411-17 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, Moscow, August 1958. A revue article that serves as a guide to the modern Russian literature to which 153 references are given, the majority in Optika i Spektroskopia and hence available in translation. The subjects dealt with are vibrational, Raman and electronic spectra with particular emphasis on fluorescence, on crystals in which the spectra of individual molecules is still discernable, on the spectra of glasses and of aromatic hydrocarbons and on the importance of intra- rather than inter-molecular processes in determining the structure of bands. P.A.Young

539.19

9810 RESEARCH IN THE LABORATORY OF MOLECULAR STRUCTURE AND SPECTRA AT CHICAGO.

R.S.Mulliken.

J. Opt. Soc. Amer., Vol. 50, No. 4, 404-5 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, Moscow, Aug., 1958. A brief description of work at Chicago, without references. The equipment and techniques used in high-resolution spectroscopy are described, work being concentrated on the absorption of gases in the range λ1200-2200 A. In particular the Vegard–Kaplan bands of N_2 have been found for the first time in absorption. The study of the absorption spectra of solutions and the theory of conjugated organic molecules is in progress. Most effort is being devoted to the computation, on a large digital computer, of molecular electronic wavefunctions. Mathematical expressions have been developed for the evaluation of interelectronic repulsion integrals for electrons attached to different nuclei. The method used is described in outline. P.A.Young

539.19

9811 OVERLAP INTEGRALS OF BeO ($B^1\Sigma \rightarrow X^1\Sigma$) SYSTEM BY APPROXIMATE ANALYTIC METHODS.

N.R.Tawde and N.Sreedhara Murthy.

Physica, Vol. 25, No. 7, 610-4 (July, 1959).

The overlap integrals of the bands of BeO ($B^1\Sigma \rightarrow X^1\Sigma$) system are calculated by both the approximate and the later improved approximate analytic methods given by Fraser and Jarmain (Abstr. 1525-6 of 1954) and the values compared with the derivations obtained from the more direct method of numerical integration involving Morse oscillator functions. The results of the improved approximate method give excellent agreement with those from the numerical integration procedure. A good deal of labour involved in the use of the latter method, namely numerical integration is saved by adopting the improved analytic method which can therefore be profitably used for the calculation of overlap integrals.

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9812 INTENSITIES IN THE TRIPLET SYSTEM OF CO BANDS. M.E.Pillow and A.L.Rowlatt.

Proc. Phys. Soc., Vol. 75, Pt 1, 162 (Jan., 1960).

The table of intensities is calculated from spectroscopic data for the triplet bonds ($d^3\pi \rightarrow a^3\pi$). The mean wave-numbers are also given because of possible doubt of the numerical assignment of the line. G.H.C.Freeman

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9813 HELIUM–NEON BANDS.

H.J.Oskam and H.M.Jongerius.

Physica, Vol. 25, No. 12, 1092-4 (Dec., 1958).

The existence of the He–Ne molecular ion in a gas discharge is confirmed by comparing the spectra of Ne, He and a mixture of the two. R.A.Newing

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9814 THE SPECTRUM OF PORPHIN-COMPLEXES AS AN EXAMPLE OF A RING FORM OF THE KUHN ELECTRON GAS. B.Rackow.

Z.Naturforsch., Vol. 15a, No. 2, 129-33 (Feb., 1960). In German.

Earlier work is reviewed, especially in relation to the electron structure of porphin compounds as determined by mesomeric properties and X-ray diffraction. The electron gas model of Kuhn is used to calculate a term scheme which is in agreement with the known double-band spectrum in the region 300-600 mμ. G.F.Lothian

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9815 THE SPECTRA OF BACTERIOCHLOROPHYLL AND -PHEOPHYTIN AS EXAMPLES OF A NET FORM OF KUHN ELECTRON GAS. B.Rackow.

Z. Naturforsch., Vol. 15a, No. 2, 134-9 (Feb., 1960). In German.

It is possible to calculate reasonably good positions of 4 bands

539.19

9793 REGULARITIES IN THE ABSORPTION OF INFRARED RADIATION IN THIN LAYERS OF CERTAIN GASES. I. THE ABSORPTION COEFFICIENT IN VIBRATION–ROTATIONAL BANDS. P.I.Bresler.

Optika i Spektrosk., Vol. 7, No. 5, 608-15 (Nov., 1959). In Russian.

General relationships are deduced for absorption in thin layers of gases consisting of molecules whose vibration–rotational bands may be represented by comparatively simple models. Approximate expressions are given for the absorption coefficient and absorbed radiation flux in vibrational–rotational bands of diatomic and more complex molecules. The absorption coefficient is deduced also for the special case of positions far from the band centre; the limits of the rotational structure and the absorption coefficient within those limits are given. The experimental data on the rotational structure of HCl and CO_2 bands agree satisfactorily with the calculated values.

A.Tybulewicz

539.19

9794 REGULARITIES IN THE ABSORPTION OF INFRARED RADIATION IN THIN LAYERS OF CERTAIN GASES. II. ABSORPTION OF RADIATION IN VIBRATION–ROTATIONAL BANDS OF CERTAIN GASES. P.I.Bresler.

Optika i Spektrosk., Vol. 7, No. 5, 616-20 (Nov., 1959). In Russian.

Formulae are derived which relate radiation flux absorbed in a comparatively thin layer of a gas to the parameters of an appropriate vibrational–rotational band. The limits of applicability of the linear and square-root laws of absorption are given. A.Tybulewicz

539.19

9795 PRESSURE BROADENING STUDIES ON VIBRATION–ROTATION BANDS. I. THE DETERMINATION OF LINE WIDTHS. D.R.Eaton and H.W.Thompson.

Proc. Roy. Soc. A, Vol. 251, 458-74 (June 23, 1959).

Methods for determining the true widths of lines in simple vibration–rotation bands are considered, and a procedure is devised for studying the effect of added gases upon the line widths in the fundamental vibration bands of deuterium chloride and carbon monoxide.

539.19

9796 PRESSURE BROADENING STUDIES ON VIBRATION–ROTATION BANDS. II. THE EFFECTIVE COLLISION DIAMETERS. D.R.Eaton and H.W.Thompson.

Proc. Roy. Soc. A, Vol. 251, 475-85 (June 23, 1959).

Using the methods described in Pt I, the line-widths in the fundamental vibration–rotation bands of deuterium chloride and carbon monoxide were measured, under conditions of self-broadening and also in the presence of added gases. The optical collision diameters were calculated and compared with the molecular diameters derived from viscosity data. An attempt is made to interpret the high effective collision diameters found in terms of intermolecular interactions of different types, and it is concluded that London dispersion forces, resonant dipole effects and quadrupole interactions may be important. The variation of line width in a band as a function of J quantum number has been measured and considered in terms of these interactions. The results suggest that further studies of this kind may throw additional light not only upon the nature of intermolecular forces but also upon the factors affecting energy transfer in collision.

539.19

9797 LINE STRENGTH MEASUREMENTS IN VIBRATION BANDS OF DEUTERIUM CYANIDE. D.R.Eaton.

Proc. Roy. Soc. A, Vol. 251, 486-92 (June 23, 1959).

The effect of vibration–rotation interaction upon line strengths in the fundamental vibration–rotation bands of deuterium cyanide was examined. The results appear to confirm an effect predicted by Gallop (Abstr. 3415 of 1958) which results in a weakening of lines in one branch of each band and a corresponding enhancement in the other branch. From the results it has been possible to determine the signs of the dipole derivatives with respect to symmetry coordinates and to clarify previous ambiguities about this.

539.19

9798 THE VIBRATION AND DECOMPOSITION OF THE HYDROGEN PEROXIDE MOLECULE.

E.K.Gill and K.J.Laidler.

Proc. Roy. Soc. A, Vol. 251, 66-75 (May 12, 1959).

A complete vibrational analysis is worked out for hydrogen peroxide, using the data of Giguère and Bain [J. phys. Chem., Vol. 56, 340 (1952)]. The FG matrix method of Howard and Wilson is employed, use being made of symmetry coordinates. The amplitude factors corresponding to each of the six normal modes of vibration are calculated. Slater's equation for the rate of energization of a molecule within which there can be no flow of energy between the normal modes is then employed to calculate rates, different choices of the critical reaction coordinate being made. The choice of the O–O distance as the critical coordinate leads to a rate of energization that is about 10^{-9} of the experimental value. The maximum possible rate predicted by the Slater equation is about 10^{-3} of the experimental value. The implications of these results are briefly discussed in terms of the hypothesis that there is a flow of energy between the normal modes of the molecule, as assumed in the treatments of Hinshelwood, Kassel, and Rice and Ramsperger.

539.19

9799 LOW TEMPERATURE INFRARED ABSORPTION SPECTRA OF ROCHELLE SALT (7000-9000 cm^{-1}) AND THE FUNDAMENTAL FREQUENCIES OF THE WATER MOLECULES. M.P.Bernard.

C.R. Acad. Sci. (Paris), Vol. 250, No. 10, 1830-2 (March 7, 1960). In French.

Spectra taken at −180°C using plane polarized radiation enable the fundamental frequencies ($\nu_1\nu_2\nu_3$) of the four water molecules of Rochelle salt (NaK $C_4H_4O_6.4H_2O$) to be calculated. The values obtained are : 3353, 1650 and 3537 cm^{-1}; 3275, 1650 and 3485 cm^{-1}; 3206, 1650 and 3413 cm^{-1}; 3049, 1650 and 3183 cm^{-1}, for the 1st, 2nd, 3rd and 4th molecules respectively. D.L.Greenaway

539.19

9800 ROTATIONAL ANALYSIS OF THE $A^1\Pi-X^1\Sigma$ SYSTEM OF SnO. A.Lagerqvist, N.E.L.Nilsson and K.Wigartz.

Ark. Fys., Vol. 15, Paper 38, 521-30 (1959).

Rotational analyses of the 1,0,0,0 and 0,1 bands of the A–X system of SnO have been carried out. The system corresponds to a $^1\Pi-^1\Sigma^+$ transition. Rotational constants for the upper and lower states have been derived. For the most abundant isotopic molecule $Sn^{120}O^{16}$ they are as follows: $B'_V = 0.3145_5 - 0.0025\,(v' + \frac{1}{2})$ cm^{-1}; $r'_e = 1.950$ A. $D'_V = [0.39 + 0.02 \times v'] \times 10^{-6}$ cm^{-1}; $B''_V = 0.3561 - 0.0022\,(v'' + \frac{1}{2})$ cm^{-1}; $r''_e = 1.832$ A. $D''_V = 0.29 \times 10^{-6}$ cm^{-1}, $\nu_e = 29624$ cm^{-1}. Several perturbations have been found in the upper vibrational levels. One of the perturbing states is probably a $^1\Pi$ state. Lines of the molecules $Sn^{120}O^{16}$ and $Sn^{116}O^{16}$ in the 0,1 band have also been measured. The shifts give $\rho_{116} = 0.99802$ and $\rho_{118} = 0.99594$.

539.19

9801 THE VIBRATION FREQUENCY OF THE TlI MOLECULE. K.S.Krasnov.

Optika i Spektrosk., Vol. 7, No. 6, 843-4 (Dec., 1959). In Russian.

Two different frequencies of the same vibration of TlI have been reported: $\omega_e = 150$ cm^{-1} and $\omega_e \cong 120$ cm^{-1}. The present note gives two physical arguments in favour of the first of these values.

A.Tybulewicz

539.19

9802 INFRARED SPECTRA OF ACETYLENE IN SOLUTION. J.Jacob.

C.R.Acad. Sci. (Paris), Vol. 250, No. 9, 1624-6 (Feb. 19, 1960). In French.

The spectrum of acetylene in the gaseous state is compared with the results obtained when dissolved in a series of organic solvents. The bands between 5000 and 750 cm^{-1} are tabulated. Large displacements observed for the antisymmetric ν_3 band indicate the formation of complexes between acetylene and some of the solvents.

D.L.Greenaway

539.19

9803 INFRARED ABSORPTION SPECTRA OF BENZENOCARBOXYLIC ACIDS. ASSIGNMENT OF VIBRATIONAL MODES TO THE RECORDED BANDS.

A.Hidalgo and F.Gonzalez-Sanchez.

J. Phys. Radium, Vol. 19, No. 5, 536-40 (May, 1958). In French.

Infrared absorption spectra of the twelve benzenocarboxylic acids have been recorded in the region from 5000 cm^{-1} (2 μ) to 400 cm^{-1} (25 μ). The substances were investigated in the solid state by the KBr pellet method. Through the use of the comparison method, an attempt has been made to relate several series of frequencies to particular vibrational modes. The spectra show the presence of a strong and complex association in all these acids.

539.19

9804 ATTEMPT AT INTERPRETATION OF THE INFLUENCE OF A NON-POLAR SOLVENT ON THE VIBRATIONAL FREQUENCY OF THE CARBONYL GROUP.

M.M.Bottreau, J.Gerbier and E.Gray.

J. Phys. Radium, Vol. 19, No. 5, 552-6 (May, 1958). In French.

Results previously obtained have shown that the vibrational frequency of the carbonyl group, about 1700 cm^{-1}, increases appreciably when the compound studied is diluted with a non-polar solvent. This increase can be regarded as the sum of a coupling effect between molecules and the "Kirkwood effect" relative to the frequency shift of an oscillator in terms of the dielectric constant of the medium. The respective share of these two effects has been shown by coupling the carbonyl group in a hydrogen-bonded complex that eliminates the coupling effect, and by studying the infrared spectra of this complex diluted with hexane. It seems that the "Kirkwood effect" is often predominant.

539.19

9805 SOLVENT EFFECT ON THE INFRARED ABSORPTIONS OF N-METHYLACETAMIDE IN THE REGION OF THE NH STRETCHING FREQUENCY.

I.Suzuki, M.Tsuboi and T.Shimanouchi.

J. chem. Phys., Vol. 32, No. 4, 1263-4 (April, 1960).

Reports absorption measurements of N-methylacetamide dissolved in ten solvents containing phenyl groups. Spectra between 3400 and 3500 cm^{-1} (the free NH stretching region) show that the absorption maximum of the NH group depends on the π-electron density in the phenyl group of the solvent molecule. The presence of a weak NH sub-band is also established. D.L.Greenaway

539.19

9806 ABSORPTION FREQUENCIES OF NEGATIVE HYDROGEN MOLECULE IONS BETWEEN 2.5 AND 44 Mc/s.

T.V.Ionescu and O.C.Gheorghiu.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2182-4 (March 21, 1960). In French.

Ions were produced by a discharge at potentials up to 5 kV, in pure hydrogen and in hydrogen mixed with neon or mercury vapour, at total pressures near 10^{-4} mm. Radiofrequency absorptions were detected (see Abstr. 123 of 1958) and discussed in relation to experimental conditions. It is suggested that a given discharge-voltage results in destruction of all negative ions for which the rotational quantum number k is less than a fixed value. J.Sheridan

539.19

9807 THE MICROWAVE SPECTRUM OF METHANOL BETWEEN 9 AND 16 kMc/s, OBTAINED WITH A CARCINOTRON AS RADIATION SOURCE.

H.D.Rudolph, H.Dreizler and W.Maier.

Z.Naturforsch., Vol. 15a, No. 3, 273-4 (March, 1960). In German.

Fifteen new absorption lines have been accurately measured, and assignments made for seven of them in accordance with existing data and theory. Coefficients in the equation for Stark effect are given for two of the lines for which this effect is chiefly linear. Two other lines of this type are classified as a K-doublet. Some advantages and limitations of a carcinotron as a radiation source are pointed out. J.Sheridan

539.19

9808 STARK EFFECT AND DIPOLE MOMENT OF CH_3CHF_2. G.H.Kwei and D.R.Herschbach.

J. chem. Phys., Vol. 32, No. 4, 1270-1 (April, 1960).

Stark effects for the M = 1, J = 1 → 2 transitions show large deviations from quadratic field-dependence, due to Stark perturbation terms connecting pairs of nearly degenerate levels. The data are accounted for by an extension of the treatment of Golden and Wilson (Abstr. 2638 of 1949). The dipole moment components derived independently from the M = 1 and M = 0 transitions are in agreement, and correspond to a total moment of 2.30 ± 0.03 D at an angle of 46.3° with the C-C bond. This agrees closely with a prediction based on bond-moments and polarizabilities. J.Sheridan

539.19

9809 RECENT DEVELOPMENT OF MOLECULAR SPECTROSCOPY IN THE U.S.S.R. B.S.Neporent.

J. Opt. Soc. Amer., Vol. 50, No. 4, 411-17 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, Moscow, August 1958. A revue article that serves as a guide to the modern Russian literature to which 153 references are given, the majority in Optika i Spektroskopia and hence available in translation. The subjects dealt with are vibrational, Raman and electronic spectra with particular emphasis on fluorescence, on crystals in which the spectra of individual molecules is still discernable, on the spectra of glasses and of aromatic hydrocarbons and on the importance of intra- rather than inter-molecular processes in determining the structure of bands. P.A.Young

539.19

9810 RESEARCH IN THE LABORATORY OF MOLECULAR STRUCTURE AND SPECTRA AT CHICAGO.

R.S.Mulliken.

J. Opt. Soc. Amer., Vol. 50, No. 4, 404-5 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, Moscow, Aug., 1958. A brief description of work at Chicago, without references. The equipment and techniques used in high-resolution spectroscopy are described, work being concentrated on the absorption of gases in the range λ1200-2200 A. In particular the Vegard–Kaplan bands of N_2 have been found for the first time in absorption. The study of the absorption spectra of solutions and the theory of conjugated organic molecules is in progress. Most effort is being devoted to the computation, on a large digital computer, of molecular electronic wavefunctions. Mathematical expressions have been developed for the evaluation of interelectronic repulsion integrals for electrons attached to different nuclei. The method used is described in outline. P.A.Young

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The table of intensities is calculated from spectroscopic data for the triplet bonds ($d^3\pi \rightarrow a^3\pi$). The mean wave-numbers are also given because of possible doubt of the numerical assignment of the line. G.H.C.Freeman

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Earlier work is reviewed, especially in relation to the electron structure of porphin compounds as determined by mesomeric properties and X-ray diffraction. The electron gas model of Kuhn is used to calculate a term scheme which is in agreement with the known double-band spectrum in the region 300-600 mμ. G.F.Lothian

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Z. Naturforsch., Vol. 15a, No. 2, 134-9 (Feb., 1960). In German.

It is possible to calculate reasonably good positions of 4 bands

in the region 370-790 mμ, by considering the electrons as a gas on the network of the molecule, allowing for the effect of the N atoms. The dependence of the band positions on solvent and the positions of the fluorescence bands are discussed. G.F.Lothian

539.19

9816 INTENSITIES OF THE RAMAN SPECTRA AND THE METALLIC MODEL OF A MOLECULE. I. POLYENE COMPOUNDS. F.A.Savin and I.I.Sobel'man.

Optika i Spektrosk., Vol. 7, No. 6, 733-9 (Dec., 1959). In Russian.

Some properties of the molecule containing conjugated double bonds can be satisfactorily represented using the metallic model. An application is described of the general metallic model method of Sobel'man (1959) to the calculation of the Raman spectral intensities of polyene compounds. The results of the calculation were found to be in satisfactory agreement with the experimental data.

A.Tybulewicz

539.19

9817 INTENSITIES OF THE RAMAN SPECTRA AND THE METALLIC MODEL OF A MOLECULE. II. AROMATIC COMPOUNDS. F.A.Savin and I.I.Sobel'man.

Optika i Spektrosk., Vol. 7, No. 6, 740-3 (Dec., 1959). In Russian.

The relative intensities of the Raman spectral lines of aromatic compounds are calculated using Sobel'man's metallic model method. Using benzene, toluene and deuterobenzene as examples, it is shown that the theoretical values are in satisfactory agreement with the experimental data. A.Tybulewicz

539.19

9818 THE ULTRA-VIOLET SPECTRA OF HF AND DF. J.W.C.Johns and R.F.Barrow.

Proc. Roy. Soc. A, Vol. 251, 504-18 (June 23, 1959).

Successful analyses have been made of the u.v. spectra excited by electric discharges in mixtures of helium with HF or DF. The spectra, which consists of large numbers of irregularly spaced lines, are shown to arise from transitions $V^1\Sigma^+ - X^1\Sigma^+$ in neutral HF and DF. State X is the ground state : state V, the lowest stable excited singlet state, probably correlated with $H^+ + F^-$. The potential minimum of state V lies at 10.5 eV above that of the ground state. The internuclear distance in this state — in agreement with theoretical predictions — is large, more than twice that in the ground state, so that the bands observed consist of transitions from low vibrational levels in V to high vibrational levels in X. In HF, the observed levels are $9 \leq v'' \leq 19$: predissociation by rotation is observed in the levels $10 \leq v'' \leq 19$. The last vibrational state which may have a few stable rotational levels is $v'' = 20$, so that, by combining the present observations with those of the vibration–rotation bands, there is now available information about the vibrational and rotational levels over the greater part of their range of stable existence in the ground state. The dissociation energy, D_0'', of HF is found to be 5.86 ± 0.01 eV.

539.19

9819 OSCILLATOR STRENGTHS OF THE ULTRAVIOLET γ BANDS OF NO. S.S.Penner.

J. Opt. Soc. Amer., Vol. 50, No. 6, 627 (June, 1960).

A critical re-examination is made of Erkovich's recent analysis (Abstr. 13162 of 1959), in which his high f-value of 0.043 is rejected in favour of the author's and others' low value of approximately 0.002. P.A.Young

539.19

9820 PARTIAL VARIATIONAL CALCULATIONS ON π-ELECTRON SYSTEMS: AN ATOMIC ANALOGUE. E.T.Stewart.

Proc. Phys. Soc., Vol. 75, Pt 1, 138-41 (Jan., 1960).

It is shown, by analogy, that even if a wave-function for a molecule is written as a function of the one-electron orbitals of all the σ-and π-electrons, it is doubtful whether the optimum forms of the π-factors, and the corresponding energies, can be obtained by variation with respect to π-parameters only.

W.J.Orville-Thomas

539.19

9821 PARAMAGNETIC RESONANCE ABSORPTION IN MOLECULAR OXYGEN. K.D.Bowers, R.A.Kamper and C.D.Lustig

Proc. Roy. Soc. A, Vol. 251, 565-74 (June 23, 1959).

Tinkham and Strandberg (Abstr. 3936, 3953 of 1955) have made a theoretical analysis of the paramagnetic resonance spectrum of molecular oxygen gas ($O^{16}O^{16}$), and obtained satisfactory agreement with their experimental results. Independent measurements at low field strengths, made by Hendrie and Kusch (Abstr. 124 of 1958), using a molecular beam method, yielded results which were not in agreement with those of Tinkham and Strandberg. The experiments of Tinkham and Strandberg have now been repeated to a higher accuracy and systematic discrepancies with their results have been observed. In these new measurements, the positions of the absorption lines have been fitted to values obtained by numerical calculations based on the theory of Tinkham and Strandberg and carried to an accuracy of 2 p.p.m. Agreement with the new experimental results to 6 p.p.m. is obtained with the following choice of the three parameters:

$$g'_s/g_s = 1 - (147 \pm 10) \times 10^{-6},$$
$$g_l/g_s = (1.405 \pm 0.015) \times 10^{-3},$$
$$g_r/g_s = (6.3 \pm 0.6) \times 10^{-3},$$

where g_s, g'_s, g_l and g_r are the spectroscopic splitting factors for the free electron spin, the electron spin in the molecule, the molecular electronic orbital moment and molecular rotational moment respectively. These values are not in agreement with those of either Tinkham and Strandberg or Hendrie and Kusch within the experimental errors quoted. As an additional check, measurements and calculations have been made on five transitions within the even rotational states of $O^{16}O^{18}$; with the same parameters as above, appropriately modified to allow for the change in isotopic mass, agreement is obtained with experiment within 10 p.p.m. Evaluation of the relativistic and diamagnetic effects (Abragam and Van Vleck see Abstr. 3282 of 1954) within the molecule gives the correct order of magnitude for the departure of g's from gs.

539.19

9822 "ATOMS IN MOLECULES": A SIMPLE APPROACH. E.T.Stewart.

Proc. Phys. Soc., Vol. 75, Pt 3, 402-11 (March, 1960).

The principles underlying Moffitt's method of atoms in molecules and Hurley's intra-atomic correlation correction are examined with the minimum of mathematical analysis, initially by reference to a wave-function not involving configuration interaction (the simplest wave-function for the lowest $^1\Sigma_u^+$ state of the hydrogen molecule). Because of variational difficulties in more complex systems, and difficulties of interpretation in all systems, it is suggested that the evidence which Hurley has presented in support of asymptotic energy adjustments, convincing though it seems, should not be taken to justify the use of the intra-atomic correlation correction as a means of improving molecular wave-functions.

539.19

9823 DENSITY MATRICES FOR WAVE FUNCTIONS BUILT UP OF TWO-ELECTRON ORBITALS. E.Kapuy.

Acta phys. Hungar., Vol. 11, No. 1, 97-101 (1960).

The second-order non-orthogonality correction has been determined for the first and second order density matrices. The energy expression using these corrections is given for the methane molecule on the basis of the molecular orbital method. R.A.Ballinger

539.19

9824 A METHOD OF DETERMINING SELF-CONSISTENT MOLECULAR ORBITALS. R.Lefebvre.

Cahiers de Phys., Vol. 13, 369-428 (Sept., 1959). In French.

A general method of determining self-consistent molecular orbitals is developed in which the orthogonality restrictions between the orbitals do not present any particular difficulty on passing from systems consisting of filled orbitals to the more complex cases containing singly occupied orbitals. It is shown that a more rapid convergence is obtained when the self-consistent Hamiltonian is modified during the course of each iteration. This is particularly important if one is limited to a single iteration. The method is illustrated by calculations on non-saturated hydrocarbon radicals, the excited states of trans-butadiene, and benzene.

W.J.Orville-Thomas

539.19

9825 IMPROVED L.C.A.O. TREATMENT OF CONJUGATED MOLECULES. I - GENERAL THEORY. APPLICATION TO HYDROCARBONS. A.Julg.

J. Chim. phys., Vol. 57, No. 1, 19-30 (Jan., 1960). In French.

Suggests a system of calculations for π-electron systems, making use of the correlation corrections to Coulomb integrals

described in Abstr. 5116 of 1959 and 13748 of 1959. Many other useful relations and approximations for the calculation of molecular integrals based on orthogonal atomic orbitals are also described. Trials on ethylene, butadiene and benzene work well. J.Hawgood

539.19

9826 CALCULATION OF THE MAGNETIC SUSCEPTIBILITY OF METHANE. H.F.Hameka.
Physica, Vol. 25, No. 7, 626-30 (July, 1959).

The magnetic susceptibility of methane is calculated by employing molecular orbitals which are constructed from gauge invariant atomic orbitals. The result is $\chi = -13.7 \times 10^{-6}$; the agreement with the experimental value $\chi = -12.2 \times 10^{-6}$ is satisfactory.

539.19

9827 A WAVE MECHANICAL STUDY OF NITRIC OXIDE. H.Brion.
Cahiers de Phys., Vol. 12, 447-77 (Dec., 1958). In French.

A non-empirical self-consistent field molecular orbital study is given for the nitric oxide molecule. This represents the first attempt at carrying out such a calculation for a non-hydride heteronuclear molecule. Theoretical estimates are obtained for molecular properties such as the total energy, bond energy, and first ionization potential (calc. 9-14 eV, expt. 9.25 eV). The sign of the molecular dipole moment is predicted to be $N^- O^+$. The wave-function used permits only partial predictions of the ultraviolet spectrum; these are in good accord with experimental data. W.J.Orville-Thomas

539.19

9828 CALCULATION OF THE MAGNETIC HYPERFINE STRUCTURE COUPLING CONSTANTS OF NO. H.Lefebvre-Brion and C.M.Moser.
Phys. Rev., Vol. 118, No. 3, 675-80 (May 1, 1960).

A calculation of the magnetic hyperfine structure (h.f.s.) coupling constants of NO has been made using an ab initio configuration interaction wave-function built from LCAO—MO—SCF orbitals. The constants predicted by this wave-function are in good agreement with experiment for the two constants related to the quantities $\langle L_z/r^3\rangle_{av}$ (constant a) and $\langle \sin^2\theta\, S^-/r^3\rangle_{av}$ (constant d). The direct calculation of $\langle (3\cos^2\theta - 1)S_z/r^3\rangle_{av}$ (constant c) gives a value which is about 25% less than that predicted by an approximation which implies that unpaired l and s are associated with the same electron. From this calculated value of c the quantity $\langle \psi^2(0)\rangle_{av} - \frac{1}{3}$ c (constant b) now is found to be about 40 Mc/s instead of 68.91 Mc/s which has neem previously used by experimentalists. The same wave function has been used to calculate the fine structure constant (spin-orbit coupling) for the $^2\Pi$ ground state of NO. The agreement with experiment is quite satisfactory. The calculation of the nuclear quadrupole coupling constant q gives about 73% of the observed electronic part assuming that $Q(N^{14}) = 0.02 \times 10^{-24}$ cm^2.

539.19 : 535.37

9829 SYMMETRY OF PORPHYRIN MOLECULES. A.N.Sevchenko, G.P.Gurinovich and K.N.Solov'ev.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 510-13 (Sept. 21, 1959). In Russian.

According to Feofilov [Dokl. Akad. Nauk SSSR, Vol. 57, 343 (1947)] the maximum polarization of fluorescence does not exceed 1/7 for molecules possessing a symmetry of the order > 3, and tends to ½ for molecules of the 2nd order. Using this criterion, the authors studied the polarization of fluorescence of porphyrins (in acid and neutral medium) and metal porphyrins (with castor oil, or HCl-saturated glycerol as solvents). Results are graphed and tabulated for tetraphenylporphyrin, Zn-tetraphenylporphyrin, mesoporphyrin, Zn-mesoporphyrin, protoporphyrin and chlorophyll, and some conclusions are reached. F.Lachman

539.19

9830 IRREDUCIBLE REPRESENTATIONS, SYMMETRY CO-ORDINATES, AND THE SECULAR EQUATION FOR LINE GROUPS. M.C.Tobin.
J. molecular Spectrosc., Vol. 4, No. 4, 349-58 (April, 1960).

The theory of irreducible representations of one-dimensional space groups is reviewed. Explicit directions for setting up representations are given and illustrated by examples. Symmetry coordinates and factoring of the secular equations for chain molecules are discussed.

539.19

9831 ELECTRONIC ENERGY LEVELS OF POLYENE CHAINS. S.Huzinaga and T.Hasino.
Progr. theor. Phys., Vol. 18, No. 6, 649-60 (Dec., 1957).

An attempt is made to treat the problem of absorption wavelength of polyene chains in the case of the alternate single and double bonds. The LCUAO MO method of Brown and Matsen is found to be useful for the problem (Abstr. 7826 of 1953). Simple calculations yield the wavelength formula,

$$\lambda = \frac{12398}{A + \sqrt{A^2 + B^2 \sin^2(\pi/N)}} \times 10^{-8} \text{ cm}$$

where A and B are the parameters of the theory and N indicates the number of π-electrons in the polyene chain. It is clear that this formula has the property of the so-called "convergence". The experimental data fits well. Possible physical implications of the present calculation are discussed in some detail.

539.19

9832 INTERNAL ROTATION IN POLYMER CHAINS AND THEIR PHYSICAL PROPERTIES. X. THE DIMENSIONS OF POLYMER CHAINS TAKING INTO ACCOUNT THE CONTINUOUS CORRELATION OF THE INTERNAL ROTATIONS IN THE NEIGHBOURING MONOMER GROUPS. Yu.Ya.Gotlib
Zh. tekh. Fiz., Vol. 29, No. 4, 523-9 (April, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 4, 465-71 (April, 1959).

Previous papers in this series have dealt with the interaction between massive side groups in adjacent monomer units in chains of the type $(CH_2\text{–}CR_2\text{–})_n$. The interaction of CH_2 groups in adjacent monomers was not taken into account. As all the successive internal rotation angles are not independent of each other, since there is interaction between all groups of atoms, the paper is devoted to a precise mathematical study of these interactions resulting in a more uninterrupted correlation between successive rotations. The rotation isomer concept is used where each monomer can only be in a certain fixed position relative to the preceding one and each position is defined by a particular set of Euler's angles. A detailed comparison of this theory with experimental data has not been made. J.S.Wilson

539.19

9833 INTERNAL ROTATION IN POLYMER CHAINS AND THEIR PHYSICAL PROPERTIES. XII. THE DIPOLE MOMENTS OF COPOLYMERS. T.M.Birshtein, L.L.Burshtein and O.B.Ptitsyn.
Zh. tekh. Fiz., Vol. 29, No. 7, 896-905 (July, 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 810-18 (Jan., 1960).

A theory of the dipole moments is proposed which relates them to the dipole moments of the polar groups, to the composition of the copolymer, to the conditions of internal rotation in the chain, and to the relative reactivity of the monomers. The theory represents the case where the conditions of internal rotation in the chain are not dependent on the composition of the copolymer. Measurements were made of the dipole moments of the copolymer of p-chlorostyrene with styrene, and previously published results for this copolymer are reassessed. The experimental results obtained are in good agreement with the theoretical curve.

539.19

9834 INTERNAL ROTATION IN POLYMER CHAINS AND THEIR PHYSICAL PROPERTIES. XIII. THE DIMENSIONS AND DIPOLE MOMENTS OF MOLECULES OF ISOTACTIC VINYL POLYMERS. T.M.Birshtein and O.B.Ptitsyn.
Zh. tekh. Fiz., Vol. 29, No. 8, 1048-57 (Aug., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 954-63 (Feb., 1960).

For Pt XII, see preceding abstract. A general method is developed for averaging the dimensions and dipole moments, taking into account the correlation between the conformations of neighbouring monomer units. This method is a variation of the matrix method of the Ising type used in the theory of ferromagnetism. It is applied to the calculation of the mean dimensions and the mean dipole moments of isotactic polymers of the type $(\text{–}CH_2\text{–}CHR\text{–})_n$, crystallizing in the form of a spiral with three monomers and one turn in a period. The results of the calculations are compared with experimental data on the dimensions of molecules of isotactic polystyrene and the dipole moments of active poly-para-chlorostyrene in solution.

539.19

9835 THE ALTERNATION OF BOND LENGTHS IN LONG CONJUGATED CHAIN MOLECULES.

H.C.Longuet-Higgins and L.Salem.

Proc. Roy. Soc. A, Vol. 251, 172–85 (May 26, 1959).

Ooshika (Abstr. 8743-4 of 1959) has found, using the self-consistent molecular orbital theory, that a cyclic polyene $C_{2n}H_{2n}$ exhibits marked bond alternation if n is very large. Here it is shown that, provided σ bond compression is taken into account, this result follows inevitably from even the simple l.c.a.o. theory, and is independent of the analytic form of either $\beta(r)$, the resonance integral, or f(r), the σ bond energy. An investigation of the linear polyenes $C_{2n}H_{2n+2}$ and $C_{2n+1}H_{2n+3}$ leads to the same conclusions, which contradict those of Lennard-Jones (1937) and Coulson (1938) but agree with those of Ooshika and of Labhart (1957). A simple calculation, based on an exponential form for $\beta(r)$, leads to a value of about 0.04 A for the difference in length between adjacent bonds in the infinite chain.

539.19 : 532.7

DIFFUSION AND SEDIMENTATION OF BRANCHED MACROMOLECULES. See Abstr. 8657

SOLID-STATE PHYSICS

539.2

9836 APPLICATION OF THE GREEN'S FUNCTION METHOD IN SOLID STATE THEORY. I.P.Dzyub.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1241-3 (Feb. 21, 1960). In Russian.

An equation is obtained by which the Green's function for exciton waves (in particular in semiconductors) is determined. A solution of the equation is given. R.Eisenschitz

539.2

9837 PROPERTIES OF THE RESTORING FORCES EXERTED ON THE ATOMS OF A CRYSTAL. (STATICS OF THE CRYSTALLINE MEDIUM). J.Laval.

J. Phys. Radium, Vol. 19, No. 5, 509-14 (May, 1958). In French.

Recent work has shown that the potential energy of a crystal cannot by analysed in diatomic terms (expressing the mutual potential energy of two atoms in each other's field of force); this energy includes triatomic terms which are at least not negligible. The statics of the crystalline medium has been reconsidered in order to take these new data into account. The total inter-atomic force (linear in proportion to displacement) exerted on an atom can still be decomposed into forces, each of them exerted by another single atom; and the interatomic forces exerted by two atoms on each other remain equal and opposite.

539.2

9838 INTERFACIAL ENERGY AND SPECIFIC ADSORPTION OF CRYSTAL SURFACES.

W.v.Engelhardt and P.J.Seil.

Naturwissenschaften, Vol. 47, No. 5, 105 (1960). In German.

Differences of the interfacial energy of freshly grown surfaces of K-Al-alum in saturated aqueous solution are demonstrated with a drop of an organic amine solution. The contact angles are different for the different crystal faces owing to the differences in interfacial energy of the (100)-, (111)-, and (110)-faces of the crystal with respect to the alum and amine solutions. R.Schnurmann

539.2

9839 DENSITY AND EXPANSIVITY OF SOLID KRYPTON. B.F.Figgins and B.L.Smith.

Phil. Mag. (Eighth Ser.), Vol. 5, 186-8 (Feb., 1960).

Debye-Scherrer powder photographs of 99.98% pure krypton were taken between 20° and 90°K and the bulk density measured between 70° and the melting point of 116°K. The results together with those of others are shown graphically. The extrapolated value for the density at absolute zero is 3.09 g cm^{-3}. The Grüneisen γ appears to have a maximum value of about 2.6 between 60° and 80°K, with an average of about 2.3 over the temperature range covered. S.Weintroub

539.2 : 551.3

DENSITY OF GLACIER ICE. See Abstr. 8362

539.2 : 532.7

COVALENCY IN THE HYDROGEN BOND AND THE PROPERTIES OF ICE. See Abstr. 8662

539.2

9840 EXPERIMENTAL FUSION CURVES OF INDIUM AND TIN TO 105 000 ATMOSPHERES.

J.D.Dudley and H.T.Hall.

Phys. Rev., Vol. 118, No. 5, 1211-16 (June 1, 1960).

The melting point was detected at various pressures by means of a sharp increase in the electrical resistance of the sample, which gave rise to a sudden increase in the sample temperature. The melting temperature of indium was found to rise smoothly from a normal value of 156°C to a value of 417°C at 105 000 atm. The experimental data are fitted very well by the Simon equation $P/a = (T/T_0)^c - 1$, with a = 15 000 atm, c = 4.34, and T_0 = 429°K. No evidence of polymorphism is observed. A phase transition is found for tin, with a triple point on the fusion curve at 38 000 atm, 318°C. The melting temperature for the first phase rises smoothly from its normal value of 232°C to the triple point, and the data are fitted very well by the Simon equation with a = 7400 atm, c = 11.3, T_0 = 505°K. The melting temperature for the second phase rises smoothly from the triple point to a value of 500°C at 105 000 atm, and the data are fitted very well by the Simon-type equation $(P - 38\,000)/21\,800 = (T/591)^{5.38} - 1$. The uncertainty is estimated to be approximately ±5% in the measured melting temperature, ±5% in the pressure calibration, ±20% in the Simon coefficient a, and ±2% in the Simon exponent c.

Lattice Dynamics

539.2

9841 NORMAL MODES OF A LATTICE OF OSCILLATORS WITH MANY RESONANCES AND DIPOLAR COUPLING. U.Fano.

Phys. Rev., Vol. 118, No. 2, 451-5 (April 15, 1960).

The normal modes of a lattice of coupled dipoles are studied as a model of the collective excitations of electrons in condensed materials. Two types of oscillations are found in which electrostatic coupling has a dominant influence. One of them is analogous to the oscillation of an electron plasma and has a high dipole moment. Other collective oscillations have a low net dipole moment, owing to a destructive interference between out-of-phase components. These two types of oscillation occur in systems with a sufficiently high density strength in space and in spectrum. A simple estimate indicates that most condensed materials fulfill this condition.

539.2

9842 LATTICE VIBRATIONS IN ALKALI HALIDES AT LIQUID HELIUM TEMPERATURES FROM EXPERIMENTAL STUDIES ON ELASTIC CONSTANTS, SPECIFIC HEATS, AND NUCLEAR MAGNETIC RESONANCE. C.F.Squire, C.V.Briscoe, M.H.Norwood, W.W.Scales and F.J.Low.

Physica, Vol. 24, Supplement, S170 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Experimental results on the elastic constants, specific heats, and spin–lattice relaxation times for single crystals of LiF, KI, and KCl are presented. The true vibration spectrum of both LiF and KI can be closely approximated by a simple model which allows the large negative ions to behave like a continuum of Debye oscillators and the small positive ions to behave like a set of independent oscillators as Einstein first proposed. All parameters are taken directly from the experimental observations. KCl does not fit into this unique situation because the Cl ion is not so relatively large. The spin–lattice relaxation time as a function of temperature for the I^{127} nucleus in single crystal and powdered KI is presented. The measurements are compared with earlier studies on LiF (Abstr. 7464 of 1957).

539.2

9843 FUNCTIONAL EQUATIONS FOR THE VIBRATIONAL SPECTRA OF DIATOMIC CHAINS.
P.Dean and J.L.Martin.
Proc. Phys. Soc., Vol. 75, Pt 3, 452-5 (March, 1960).

A generalization of the method presented in Abstr. 7493 of 1959 to take into account correlation between matrix elements, allowing the derivation of a system of equations for the spectrum of the general binary lattice subject to nearest-neighbour harmonic forces.
J.Hawgood

539.2

9844 THEORY OF THE LATTICE VIBRATIONS OF GERMANIUM. W.Cochran.
Proc. Roy. Soc. A, Vol. 253, 260-76 (Nov. 24, 1959).

Previous attempts to explain the frequency–wave number relations for the normal modes of germanium, which were determined experimentally by Brockhouse and Iyengar (Abstr. 2892 of 1959) have required the assumption of force constants between atoms which are relatively far apart. The theory then involves a large number of undetermined parameters which have no obvious physical justification, and the fact that the elastic constants of germanium satisfy an identity which might suggest that only interactions between adjacent atoms are important, has to be dismissed as a coincidence. In this paper the Born–von Karman theory of lattice dynamics is extended to apply to a simple model of the germanium crystal, in which each atom is regarded as a charged core coupled to an oppositely charged shell. This gives the atom the property of polarizability, not only in an electric field but also under the influence of bonding interactions between adjacent atoms. On the basis of this model, the frequency–wave number relations can be reasonably well accounted for with only two disposable parameters, and a simple explanation is provided of the fact that the elastic constants satisfy Born's identity. The value deduced for the polarizability of a germanium atom, using the neutron spectroscopy data of Brockhouse and Iyengar, is in good agreement with that determined directly from the dielectric constant. An extension of the theory of Mashkevich and Tolpygo (Abstr. 5461 of 1958) provides some theoretical justification for the use of a shell model for germanium.

539.2 : 517

TABLES OF THE MODIFIED BESSEL FUNCTIONS FOR LATTICE CALCULATIONS. See Abstr. 6541

539.2 : 530.16

EXACT SOLUTION OF THE ASSOCIATION PROBLEM IN CRYSTAL LATTICE MECHANICS BY A MATRIX-SPINOR METHOD. See Abstr. 8559

539.2 : 534.22

9845 THE SCATTERING OF LIGHT BY ULTRASONIC WAVES IN GLYCINE SULPHATE. A.Zarembovitch.
C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2700-1 (April 11, 1960). In French.

A crystal is subjected to ultrasonic waves, while illuminated by a parallel beam of light. At resonance, the diffraction pattern has a maximum intensity. The velocity of the ultrasonic waves can then be determined. If now the temperature of the crystal is slowly raised, the velocity shows a discontinuity at 50° C.
R.W.Fish

539.2

9846 EXPERIMENTS ON THE ACOUSTO-ELECTRIC EFFECT. P.Smith and D.O.Sproule.
Nature (London), Vol. 184, 264 (July 25, 1959).

The prediction of Parmenter and of Gurevich, that a single longitudinal acoustic wave passing along a metal or semiconductor should produce a steady p.d. in the material, has been confirmed for germanium by Weinreich and White, and by Sasaki and Yoshida. In the present experiments no effect was found in copper and aluminium although the predicted effect was several thousand times the minimum detectable signal.
C.A.Hogarth

539.2

9847 ELECTRONIC STRUCTURE OF TIN INVESTIGATED BY ULTRASONIC ATTENUATION. T.Olsen.
Phys. Rev., Vol. 118, No. 4, 1007-8 (May 15, 1960).

The magnetic field dependence of the ultrasonic attenuation was measured in very pure tin single crystals. Oscillations were found that can be explained as a result of resonant conditions between the electron orbit diameter and the periodic field set up by the sound wave. These oscillations yield information about the Fermi-momentum, and the general features of a possible electron distribution in tin are suggested.

539.2

9848 THE VELOCITIES OF SOUND IN SOLID ARGON. E.R.Dobbs and A.G.Betjemann.
Physica, Vol. 24, Supplement, S181-S182 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The ultrasonic interferometer of Barker and Dobbs (Abstr. 9995 of 1955) has been improved and adapted for measurements on solidified gases at liquid hydrogen temperatures. This apparatus is described and recent measurements of the velocities of sound in solid argon are discussed. The adiabatic compressibility deduced from these measurements is compared with the isothermal compressibility obtained by Stewart, using the piston-displacement method, and with recent calculations based on a (12,6) inter-atomic potential.

539.2

9849 THE EFFECT OF THE DIRECTION OF A TRANSVERSE MAGNETIC FIELD ON THE ELECTRONIC COMPONENT OF ULTRASONIC ABSORPTION IN A LEAD SINGLE CRYSTAL.
L.Mackinnon, A.Myers and M.T.Taylor.
Proc. Phys. Soc., Vol. 74, Pt 6, 773-5 (Dec., 1959).

The direction of magnetic fields of up to 4690 Oe, applied perpendicular to the propagation [100] direction of longitudinal and transverse 10-70 Mc/s ultrasonic waves in a lead single crystal (purity > 99.995%) at 4.2° K, was varied through 360°; the resultant attenuation variations are shown as polar graphs.
L.Mackinnon

539.2

9850 RESONANCE ABSORPTION OF ULTRASOUND ON NUCLEI. A.R.Kessel'.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1451-6 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol.36(9), No. 5, 1031-4 (Nov., 1959).

An analysis is given for resonance absorption of ultrasound on paramagnetic nuclei in a simple cubic lattice under the assumption that the spin–lattice interaction is due to nuclear quadrupole forces. Absorption factors for the spin transitions characterized by $\Delta m = 1$ and $\Delta m = 2$ are obtained for arbitrary directions of propagation and polarization of the acoustic waves. A comparison between theory and experiment is made for In^{115} in InSb.

539.2

9851 THE RESONANCE OF CHARGE CARRIERS PRODUCED BY AN ULTRASONIC WAVE. E.P.Pokatilov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1461-4 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1037-9 (Nov., 1959).

The interaction is considered of charge carriers situated in a magnetic field with the electric field produced by an ultrasonic wave. The power absorbed in unit volume is calculated for charges with scalar and tensor effective masses. The curve for absorbed energy has beaks where the ultrasonic frequency is $n\omega_0$ (n being at integer and ω_0 the cyclotron frequency of the carrier), provided the relaxation time $\tau \gg 1/\omega_0$. Because the ultrasonic wavelength is about 10^5 times smaller than that of light at the same frequency, polarization effects should be absent in experiments on ultrasonic resonance; this prevents the use of cyclotron resonance in semiconductors with a high concentration of free electrons.

539.2 : 536.63

9852 THE SPECIFIC HEAT OF CRYSTALLINE QUARTZ BETWEEN 2° K AND 4° K.
G.H.S.Jones and A.C.Hollis Hallett.
Canad. J. Phys., Vol. 38, No. 5, 696-700 (May, 1960).

Measurements of the specific heat over the range 2-4° K are fitted to a T^3 law and a value 470 ± 10° K is deduced for the equivalent Debye temperature of quartz.
J.W.Leech

539.2 : 536.63

9853 THE TRUE SPECIFIC HEATS OF IRON, NICKEL AND CHROMIUM AT HIGH TEMPERATURES. NEW METHODS FOR THE MEASUREMENT OF THE TRUE SPECIFIC HEATS OF METALS AT HIGH TEMPERATURES. H.Lange and R.Kohlhaas.

ForschBer. Landes Nordrhein-Westfalen, No. 797, 115 pp. (1960). In German.

A detailed description of the apparatus used and measurements made by Holetzko (Dissertation, Cologne University, 1952) on Fe between 20° and 1450°C; Warncke (Dissertation, Cologne University, 1953) on Ni between 180° and 1160°C; Krauss (Zeitschrift für Metallkunde, Vol. 49, 386-92, 1958) on Cr between 700° and 1300°C; and Martin (Diplomarbeit, Cologne University, 1958) on Cr between 20° and 1410°C; together with a description of the theoretical discussion of Krauss and Warncke on Ni (Zeitschrift für Metallkunde, Vol. 46, 61-9, 1955). 83 references. S.Weintroub

539.2

9854 THE RELATIONSHIP BETWEEN CERTAIN THERMAL PARAMETERS OF SOLIDS. V.S.Neshpor.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 559-64 (1959). In Russian.

Various theoretical and semi-empirical formulae are discussed relating melting point (T_s, °K), Debye temperature (Θ, °K), Young's modulus (E), molar or atomic weight (M, g) molar or atomic heat (C, cal(deg C)$^{-1}$ mole^{-1}), coefficient of linear expansion (α), density (γ, g/cm^3). Composite formulae are derived and tested against experimental data for about 60 solids including metals, crystals of metallic character (carbides, borides and nitrides) and ionic crystals. The following formulae are found to be reliable (in the units given above)

$$\Theta = 15.14\, C^{1/3}\gamma^{1/3} M^{-1/3} \alpha^{-1/2}$$

for all crystals.

$$\alpha = 7.24 \times 10^{-3} T_s^{-1.17}$$

for crystals of metallic type; and

$$\alpha = 11.5 \times 10^{-3} T_s^{-1.17}$$

for alkali-halide type crystals. The Lindemann formula

$$\Theta = 137\, T_s^{1/2} \gamma^{1/3} M^{-1/2}$$

gives only qualitative agreement but

$$\Theta = 12.45\, T_s^{0.73} C^{1/3} \gamma^{1/3} M^{-1/2}$$

gives excellent agreement for metallic-type crystals.

A.F.Brown

539.2

9855 SPECIFIC HEAT OF SOME RARE EARTH IRON GARNETS AND YIG AT LOW TEMPERATURES.

H.Meyer and A.B.Harris.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 49S-50S (May, 1960).

Heat capacity measurements of the iron garnets of Y, Gd, Er, Ho, and Yb between 1.4° and 20°K are presented. Below 5°K, the specific heat of YIG can be represented by the sum of a lattice term proportional to T^3 and the spin-wave contribution $2.15 \times 10^{-2} T^{3/2}$ joules mole^{-1} deg^{-1} C. This last term agrees satisfactorily with that calculated from a spin-wave analysis, in which the exchange interaction coefficients were those derived from Pauthenet's magnetization data. The results of the magnetic specific heat of the rare earth ions could be interpreted in terms of a Weiss molecular field acting on these ions. For Gd^{3+} and Yb^{3+}, this field was found to be, respectively, about 3.0×10^6 and 1.5×10^5 Oe below 20°K, in satisfactory agreement with that derived from Pauthenet's data.

539.2

9856 NUCLEAR QUADRUPOLE AND ELECTRONIC HEAT CAPACITIES OF BISMUTH. N.E.Phillips.

Phys. Rev., Vol. 118, No. 3, 644-7 (May 1, 1960).

The heat capacity of bismuth was measured from 0.1 to 2.0°K and found to be represented by

$$C = 2.8 \times 10^{-7} T^{-2} + 2.1 \times 10^{-4} T + 1944(T/\theta)^3 \text{ joules/mole deg}$$

with $\theta = 120.4 - 0.6T^2$. The T^{-2} term in the heat capacity is assumed to be associated with the alignment of the nuclear electric quadrupole moment in the electric field gradient of the crystal and is used to obtain the value 25 Mc/s for the quadrupole coupling constant. The linear term is used, together with known parameters for the electrons in the conduction band, to obtain an average effective mass for the holes in the valence band of 0.9 times the free electron mass.

539.2

9857 ATOMIC HEAT OF SODIUM METAL FROM 0.4 TO 2°K. R.E.Gaumer and C.V.Heer.

Phys. Rev., Vol. 118, No. 4, 955-7 (May 15, 1960).

The atomic heat was measured from 0.4° to 2°K using the magnetic refrigerator calorimeter (Abstr. 2286 of 1958). The experimental data is given by $C = 1.32T + 0.485\, T^3$ millijoule/mole-°K. No anomaly is observed in this temperature range. The experimental value of the electronic specific heat and the Pauli spin paramagnetism measured by Schumacher and Slichter are used for comparison with the electronic band theory of sodium and with those modifications introduced by electron–electron and lattice–electron interactions.

539.2

9858 HEAT CAPACITY OF SODIUM AND POTASSIUM AT TEMPERATURES BELOW 1°K.

W.H.Lien and N.E.Phillips.

Phys. Rev., Vol. 118, No. 4, 958 (May 15, 1960).

The heat capacities were measured from about 0.15°K to just above 1°K. No anomaly was observed in either case: the heat capacity could be represented by the sum of a term linear in temperature and a cubic term. Values of the Debye temperatures and effective masses of the conduction electrons are given.

539.2

9859 HEAT CAPACITIES OF SOME DILUTED ALLOYS OF MANGANESE IN SILVER AND COPPER.

J.De Nobel and F.J.Du Chatenier.

Physica, Vol. 24, Supplement, S175 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Heat capacities of diluted alloys of Mn in Ag and Cu have been measured in the region of 1.4 to 20°K in order to verify the theory of Korringa-Gerritsen. Measurements are still in progress, in zero magnetic field as well as in fields of approximately 5 and 15 kOe. The maximum in the c/T v. T curve lying in the lower helium region is flattened when a magnetic field is applied. The magnetic entropy per mole alloy lies between cR ln 5 and cR ln 6, where c is the concentration and R the gas constant. The temperature of the maximum as a function of concentration needs some further consideration.

539.2 : 536.48

9860 HYPERFINE COUPLING IN METALS. C.V.Heer.

Physica, Vol. 24, Supplement, S155-S156 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The evaluation of the anomalous specific heat in transition metals below 1°K which is attributed to the hyperfine coupling between the nucleus and the electronic magnetic moment of the atom is of considerable importance in the study of the orientation of nuclei in ferromagnetic materials, in the study of the electronic wave-functions in metals, and in low temperature research. The measurement of the specific heat of metallic cobalt has been extended to lower temperatures on the same cobalt specimen and with the same magnetic refrigerator-calorimeter which were used by Heer and Erickson (Abstr. 2286 of 1958). Data in agreement with that previously reported is obtained. The anomalous specific heat or that part of the specific heat in excess of the electronic and lattice contribution, $C/R = 4.0 \times 10^{-4}/T^2$ is not in complete agreement with the value suggested by the anisotropy of the γ-ray emission of metallic cobalt. The small molar volume of the cobalt metal gives rise to a hyperfine coupling specific heat per unit volume comparable to the specific heats of paramagnetic salts, and suggests that cobalt or other similar metals will be very effective as low temperature heat reservoirs. Below 0.1°K an observable anomaly is expected in iron, nickel, etc.

539.2

9861 THE THERMAL AND ELECTRICAL BEHAVIOUR OF SOME METALS IN THE IMPURITY-SCATTERING REGION. A.R.De Vroomen and C.Van Baarle.

Physica, Vol. 24, Supplement, S171-S172 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The residual electrical resistivity, R, heat conductivity, K, and absolute thermoelectric power, S, have been measured simultaneously between 1.5 and 9°K for about 30 pure metals and alloys such as Sn, Sn–Bi, Al, Al–Mg, Zn, Ag–Pd and Cu–Ni. In all cases RK/T approaches $\frac{1}{3}(\pi k/e)^2 \pm 2\%$ and R becomes independent of T, if T is sufficiently low. Deviations from the Wiedemann–Franz–Lorenz law at the higher temperatures are readily interpreted as due to electron scattering by phonons for the purest metals and to the lattice conduction, K_g, for the alloys. For Zn anomalies similar to Mg [Encyclopedia of Physics, Vol. 14,

247 (1958)] have been found. As no minimum in R could be detected it is believed that there is a contribution to K from lattice conduction with an anomalous K_g of about 10^{-2} T watt cm^{-1} deg^{-1} over most of the T range. Theoretically, S/T should be constant in the impurity scattering range. Experimentally, considerable deviations occur in all specimens studied. These were explained on the basis of calculations of a contribution S_g to S_e resulting from phonon-drag (Gurevich-effect). For Sn, Al and their alloys $S_g \propto T^3$ with absolute values in agreement with Klemen's theory. In Zn, $S_g \propto T^2$ in agreement with the(anomalous) T-dependence of K_g. For Cu–Ni and Ag–Pd -S/T increases for $T \to 0$. No correlation with lattice conduction upon straining or alloying could be detected here.

539.2

9862 TRANSPORT PHENOMENA IN METALS. A.H.Wilson.

Physica, Vol. 24, Supplement, S98-S101 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A brief review of some current problems, in particular the thermoelectric effect. R.G.Chambers

539.2

9863 TRANSPORT PROPERTIES OF DILUTE ALLOYS OF COPPER. R.L.Powell, W.J.Hall and H.M.Roder.

Physica, Vol. 24, Supplement, S176 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements have been resumed on the transport properties, (thermal conductivity, electrical conductivity, and thermal e.m.f.) of dilute alloys of copper in the temperature range 4°K to 120°K. The three samples completed contain respectively about 150, 350, and 650 ppm of silver in high-purity copper (99.999%). As usual, it is assumed that the total conductivities are determined by electronic transport and that both are limited by two scattering mechanisms: intrinsic scattering and imperfection scattering. The total electronic thermal resistance consists of three components; the intrinsic resistance W_i, the imperfection resistance W_0, and an interaction resistance W_{id} of the form suggested by Sondheimer and Wilson. The Lorentz ratio does not extrapolate to the classical value at 0°K, but depends upon the imperfections in the sample. The alloying effects upon the three properties are compared with recent theories on scattering mechanisms for transport properties.

539.2

9864 HEAT CONDUCTIVITY OF LiF WITH VARYING CONCENTRATIONS OF ^{6}Li AND ^{7}Li. R Berman.

Physica, Vol. 24, Supplement, S169 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Although the scattering of single phonons by isotopes can be calculated, the evaluation of the resulting thermal resistance is difficult because this involves the whole spectrum of mutually interacting phonons. Ziman (Abstr. 397 of 1958) has shown how an upper limit of resistance can be calculated; for relatively small isotope scattering the actual resistance will be equal to this, but for larger concentrations the resistance should increase less rapidly than c(1 − c). Measurements in progress on LiF crystals, in which the Li^6 concentration varies from 5 to 90%, confirm this theory: as c (or 1 − c) approaches zero the resistance agrees well with the upper limit, and with c increasing the resistance falls below proportionality to c(1 − c). For c = 0.5 the resistance is about one-tenth of the calculated upper limit.

539.2

9865 THE LATTICE HEAT CONDUCTIVITY OF COPPER-ZINC ALLOYS. J.N.Lomer and H.M.Rosenberg.

Physica, Vol. 24, Supplement, S169-S170 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The heat conductivity of copper-zinc single crystals (with up to 30% Zn) has been measured in the range 2 to 90°K and from these results the lattice heat conductivity, K_g, has been deduced. In the liquid helium range K_g is of the form AT^3 and is presumably limited by the scattering of the lattice vibrations by the free electrons. The value of A was unchanged for the first few percent of zinc which was added, but it decreased rapidly after further addition of zinc. This decrease is interpreted in terms of the increasing density of states at the Fermi surface as the Brillouin zone is gradually filled with the extra electrons from the zinc.

539.2

9866 THE INFLUENCE OF A MAGNETIC FIELD ON THE LOW TEMPERATURE THERMAL CONDUCTIVITY OF FERRIMAGNETIC CRYSTALS. S.A.Friedberg and D.Douthett.

Physica, Vol. 24, Supplement, S176 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The thermal conductivities of single crystal specimens of manganese, cobalt–zinc, and manganese–zinc ferrites were measured between 1.5° and 25°K in a longitudinal magnetic field of about 10 kOe as well as in zero field. Those specimens having low zero field conductivity (manganese and cobalt-zinc ferrite, K ~ 1.5 mW/cm°K at 4°K) exhibited significant positive magneto-conductivities. For example, $\Delta K/K_0 \cong 0.2$ for manganese ferrite at 2°K. A reasonable explanation of these observations may be given if the heat current is assumed to be carried primarily by phonons and that these are scattered by spin waves. Application of an external field reduces this scattering, allowing the conductivity to increase.

539.2

9867 THE THERMAL CONDUCTIVITY OF MONOISOTOPIC IONIC CRYSTALS (SODIUM FLUORIDE AND CESIUM IODIDE) AT LOW TEMPERATURES. A.Foner-Cohen.

Physica, Vol. 24, Supplement, S177 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The thermal conductivity, K, of single crystals of NaF was measured at low temperatures. In the best crystal, K_{max} was ~ 30 W/cm deg at a temperature $T_{max} \cong 17°K$. This crystal exhibited the exponential behaviour expected at $T > T_{max}$ for crystals free of isotope scattering. In comparing K (from 3° to 30°K) of NaF crystals from different sources with nearly the same chemical purity it appears that strains and grown-in defects are important factors limiting K. In the CsI, although the exponential behaviour is observed at T > 11°K, at the lowest temperatures K appears to be limited by the large density of dislocations present in this plastic crystal. In CsI containing 0.2% Tl the impurity scattering as well as dislocations limit K. Upon thermal annealing of the Tl doped crystal K is increased somewhat, indicating partial annealing of dislocations.

539.2

9868 THERMAL CONDUCTIVITY OF THE SOLIDIFIED INERT GASES: ARGON, NEON AND KRYPTON. G.K.White and S.B.Woods.

Physica, Vol. 24, Supplement, S177 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The heat conductivities of three solids, argon, neon and krypton contained in an inconel tube, have been measured at temperatures from 2°K to near their melting points. At temperatures above about 15°K, the heat conductivity, λ_l may be represented by $\lambda \cong B/T$ where B has values of 250 mWcm^{-1} for A, 75 for Ne and 270 for Kr. These values are somewhat lower (by 20 to 40%) than those calculated from theoretical treatments of lattice anharmonicity for simple crystal models. At liquid helium temperatures, λ appears to vary as T^2 and is rather small, corresponding to mean free paths of 10^{-4} to 10^{-3} cm for the lattice waves. Perhaps severe internal strains, which probably limit the conductivity at these lower temperatures, may be avoided by producing the solid in a container which allows it to contract with less constraint during cooling.

539.2

9869 PRELIMINARY MEASUREMENTS OF THE THERMAL CONDUCTIVITY AND EXPANSION OF ICE. R.W.Powell.

Proc. Roy. Soc. A, Vol. 247, 464-6 (Oct. 21, 1958).

Results are reported for the thermal conductivity of H_2O and D_2O in the solid and liquid phases between −10° and +20°C, and also for the thermal expansion of single crystal ice parallel and perpendicular to the optic axis between 0° and −200°C. R.F.S.Hearmon

539.2

9870 NOTE ON BLOCH–NORDSIECK TRANSFORMATION AND ELECTRON LATTICE INTERACTION. H.Kanazawa.

Progr. theor. Phys., Vol. 17, No. 2, 304-5 (Feb., 1957).

Bardeen (Abstr. 2718 of 1952) used this transformation to effect a replacement of electron–lattice vibration interaction terms by others involving electron–electron interactions. The present work further develops the transformation to eliminate second order terms in the expression for the interaction energy. J.W.Leech

539.2

9871 TWO-PHONON INDIRECT TRANSITIONS AND LATTICE SCATTERING IN Si. W.P.Dumke.
Phys. Rev., Vol. 118, No. 4, 938-9 (May, 15, 1960).

The probability of indirect transitions with the emission of two phonons is calculated. Several of the intensity maxima in the intrinsic low-temperature emission spectrum of Si (Abstr. 8107 of 1959) are explainable in terms of these transitions. Scattering matrix elements obtained from an analysis of the observed emission spectrum indicate that intervalley scattering is the dominant scattering mechanism for electrons in Si, with 0.023 and 0.046 eV longitudinal acoustic mode phonons umklapp-scattering electrons between valleys on the same and on different crystal axes, respectively. The valleys are approximately 82% of the way from the centre to the edge of the Brillouin zone. Optical mode scattering in the valence band is largely responsible for the anomalous temperature dependence of the intrinsic hole mobility.

539.2

9872 DISPERSION OF ELECTRON WAVES IN A RANDOM LATTICE. J.Korringa.
Physica, Vol. 24, Supplement, S171 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The residual resistance of an imperfect metal, though commonly obtained from a transport equation, appears as the imaginary term in the dispersion relation for electrons in the (perturbed) lattice. This dispersion theory is sketched for the special case that two atomic species, A and B, are randomly distributed in an otherwise perfect lattice, in concentrations C_A and C_B. The basic results are: (1) The stationary states closely resemble Bloch waves; in two "cells" occupied by A-atoms the wave-function differs mainly by a phase factor; the same holds for B-cells. The phase difference is of the form $\mathbf{k}.\mathbf{R}_{ij} + \eta_{ij}$, where R_{ij} is the vector distance between the two lattice points, and where η_{ij} is a "phase error". For fixed R_{ij} the phase errors have a Gaussian distribution, with a width $\sigma_{ij} = \sqrt{\alpha R_{ij}}$. (2) The value of $\alpha(k)$ and the energy $E(k) = \hbar^2k_0^2/2m$, appear together as a complex eigenvalue of Schrödinger's equation in a periodic, but complex and velocity-dependent potential. The scattering matrix, corresponding to this potential in any lattice cell, is given by $U = (1 - i\alpha/k_0)(C_A U_A + C_B U_B)$, where U_A and U_B are the scattering matrices corresponding to the (real) potentials in an A- and B-cell respectively. The latter can be obtained by a self-consistent iteration method. The value of α for states at the Fermi-level is proportional to the resistance tensor; the function $k_0^2(k)$ describes the band structure of the system.

539.2

9873 SOME APPLICATIONS, IN THE THEORY OF METALS, OF THE METHOD OF SUMMATION OF THE MAIN FEYNMAN DIAGRAMS. Yu.V.Tsekhmistrenko.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1546-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1097-9 (Nov., 1959).

Starting from the condition that the average phonon energy must be small compared with the average energy of the electron transitions, a Hamiltonian is constructed with a direct electron–electron interaction which describes, in the given approximation, a Frühlich system of interacting electrons and phonons.

539.2

9874 THE STATE OF d ELECTRONS IN TRANSITION METALS. C.Herring.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 3S-11S (May, 1960).

A brief critique is given of the principal types of theoretical pictures which have been advanced concerning the electronic states of transition metals, especially those of the iron group. Attention is drawn to the possibility that some of the properties of these metals can be correlated by the use of concepts which have an exact, not just approximate, meaning for a many-electron system. The Fermi surface is probably a concept of this type. Major conclusions are that in the iron group metals the 3d electrons ought not to differ radically from those in the free atoms either in number or in spatial distribution, and that in most, though perhaps not all, of these metals the 3d electrons, magnetic or nonmagnetic, have an itinerant behaviour.

539.2

9875 SYMMETRICAL PROPERTY OF EIGEN-FUNCTIONS OF AN ELECTRON IN A ONE-DIMENSIONAL PERIODIC POTENTIAL FIELD. S.Okada.
Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 3, 130-7 (Oct., 1958).

The symmetry of eigen-functions of an electron belonging to an allowed energy band is determined for a one-dimensional periodic potential field, which is assumed to be given by a train of rectangular potential wells. A relation between symmetry and an energy eigen-value is obtained. For a potential field, for a defect situated in the centre of the periodic potential field, it is found that symmetry of an eigen-function belonging to a discrete eigen-value due to the defect is related to the symmetry of the eigen-function of the edge of an allowed band.

539.2

9876 DISCRETE STATES OF AN ELECTRON IN A ONE-DIMENSIONAL PERIODIC FIELD HAVING A DISLOCATED CELL. T.Hayasi, S.Teruyama and T.Sagawa.
Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 3, 138-43 (Oct., 1958).

For a one-electron problem in a one-dimensional periodic potential field having a dislocation, the existence of discrete energy eigen-values is shown by an example. The potential energy of an electron is assumed to be expressed by a train of square wells, which is periodic except near a dislocated cell. Numerical calculation is performed for a case where the dislocation is expressed by simple displacement of a square well. For such a field it is shown that two discrete eigen-states of an electron exist in each so-called forbidden band, and each of them is located near each allowed band edge.

539.2

9877 ON A.RAYCHAUDHURI'S PAPER "ELECTRONIC ENERGY BANDS IN MODEL THREE-DIMENSIONAL LATTICES". P.Schwed and G.Allen.
Z. Phys., Vol. 158, No. 5, 623-4 (1960).

Discusses Abstr. 8741 (1957). It is pointed out that one of the simplifying assumptions made by Raychaudhuri is invalid, but that there is a possibility of obtaining a correct procedure which retains many of the advantages of Raychaudhuri's approach.

539.2

9878 THE MOTION OF AN ELECTRON IN A CRYSTAL LOCATED IN AN EXTERNAL FIELD. G.E.Zil'berman.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1465-71 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1040-3 (Nov., 1959).

Various forms of the equations of motion of an electron with an arbitrary dispersion law in a uniform magnetic and arbitrary electric fields are considered. A transition from the exact equation to approximate ones involves neglected values which are estimated. Special attention is paid to the nondiagonal terms (due to neighbouring energy bands).

539.2

9879 ELECTRON-RELAXATION PROCESSES IN TITANIUM DIOXIDE. L.I.Reimerov.
Zh. tekh. Fiz., Vol. 29, No. 2, 261-6 (Feb., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 2, 229-33 (Feb., 1959).

The electron states near a defect in titanium dioxide are discussed and it is shown that to determine these states it is necessary to allow for the polarization of the parent medium by the defect. Relaxation processes, with time constant $\tau = 10^{-3}$-10^{-4} sec at room temperature, are predicted at these electron states in agreement with the experimental data on titanium dioxide quoted.

R.Bullough

539.2

9880 EFFECT OF OXIDATION ON THE CHARACTERISTIC LOSS SPECTRA OF ALUMINUM AND MAGNESIUM. C.J.Powell and J.B.Swan.
Phys. Rev., Vol. 118, No. 3, 640-3 (May 1, 1960)

For previous work, see Abstr. 274,1273 of 1960. Measurements of the characteristic electron energy loss spectra were made (in a reflection experiment) during oxidation of a fresh evaporated layer of either metal. It was found that surface oxidation results in the rapid disappearance of the low-lying energy losses (10.3 eV in aluminium and 7.1 eV in magnesium) and the appearance of modified low-lying losses of 7.1 eV in aluminium and 4.9 eV in magnesium. The general changes in the loss spectra and the particular changes in the spectrum of aluminium were in good agreement with the predictions of Ferrell and Stern.

539.2

9881 ENERGY BANDS IN THE PRESENCE OF AN EXTERNAL FORCE FIELD. II. ANOMALOUS VELOCITIES. E.N.Adams and E.I.Blount.
J. Phys. Chem. Solids, Vol. 10, No. 4, 286-303 (Aug., 1959).

The theory of field-modified energy bands is extended to include the effect of weak scattering forces on the energy band structure. The modified current operator is found to contain terms giving anomalous currents of a type previously treated by Karplus and Luttinger (Abstr. 10366 of 1952) in connection with electrical conduction in ferromagnets. The physical meaning of these currents is discussed, and they are shown to be analogous to spin-dependent currents in Dirac's theory of the electron. They may be regarded formally as resulting from a non-commutability of the components of the co-ordinates. It is shown that such currents, proportional to the acceleration, are caused by every accelerating mechanism, including scattering mechanisms. A classical transport theory including the anomalous currents is derived, valid for scattering mechanisms for which the momentum transfer per collision is small, and a very simple problem carried through by way of example. A formal theory including the anomalous transport currents is given for the general case of arbitrary scattering mechanism and overlapping bands. A critique is given of some recent theories of the spontaneous Hall effect in ferromagnets.

539.2

9882 AN ENERGY BAND INTERPOLATION SCHEME, WITH APPLICATION TO BODY-CENTRED CUBIC LITHIUM. J.F.Cotnwell and E.P.Wohlfarth.
Nature (London), Vol. 186, 379-80 (April 30, 1960).

The energy levels were computed on the basis of the calculations of Abstr. 2648 of 1958 and an interpolation scheme using a repulsive pseudo-potential and plane wave expansions of the wave functions. The density of states curve, the Fermi energy and the parameters describing the levels near the zone centre were calculated.

E.P.Wohlfarth

539.2

9883 THEORY OF THE VALENCE BAND STRUCTURE OF GERMANIUM IN AN EXTERNAL MAGNETIC FIELD. R.F.Wallis and H.J.Bowlden.
Phys. Rev., Vol. 118, No. 2, 456-61 (April 15, 1960).

The energies of the magnetic sub-bands associated with the V_1 and V_2 valence bands in germanium have been calculated as a function of k_z, the propagation constant parallel to the external magnetic field. Warping of the V_1 and V_2 bands was neglected. Sub-bands belonging to the 1^+ and 2^+ ladders (light holes) have minima at $k_z = 0$ and show quantum effects consisting of a decrease in curvature as the valence band edge is approached. Sub-bands belonging to the 2^- ladder (heavy holes) also have minima at $k_z = 0$, but the curvature increase near the valence band edge. The 1^- heavy hole sub-bands show very marked quantum effects. The sub-band minima occur at values of k_z different from zero, and local maxima appear at $k_z = 0$. The peculiar nature of the 1^- magnetic sub-bands may lead to observable effects in various magneto-optic phenomena in germanium.

539.2

9884 GENERALIZATION OF BAND THEORY TO INCLUDE SELF-ENERGY CORRECTIONS. G.W.Pratt,Jr.
Phys. Rev., Vol. 118, No. 2, 462-7 (April 15, 1960).

A one-particle Schrödinger-like equation is found whose eigenvalues in certain cases are indentical with the energies of the many electron states of a semiconductor or insulator including self-energy corrections. The one particle Hamiltonian is expressed in terms of the Coulomb interaction as modified by polarization processes. The relation is given between the modified Coulomb interaction and the dielectric function which is the generalization of the classical dielectric constant. Suggestions are made as to how the one-particle equation including self-energy effects might be solved in practice.

539.2

9885 CUBIC FIELD SPLITTING OF D LEVELS IN METALS. J.Callaway and D.M.Edwards.
Phys. Rev., Vol. 118, No. 4, 923-7 (May 15, 1960).

For previous work, see Abstr. 13785 of 1959. The splitting of the fivefold degeneracy of free atom d-electron states by non-spherical components of a crystalline field is calculated. The crystal potential employed is that of a lattice of positive point charges screened by a uniform distribution of electrons. The calculation is done to first order in the cubic field, using hydrogenic electron wave-functions. The triply degenerate d state is lowered with respect to the doubly degenerate one in both body-centered and face-centered cubic lattices. Numerical results are given for both lattices. Finally, analytic atomic wave-functions are used to estimate the splitting in iron and copper at the observed lattice spacing. The crystal field splitting of these levels is found to be much smaller than the overlap splitting as obtained in previous calculations for both materials.

539.2

9886 EFFECT OF CRYSTALLINE FIELDS ON CHARGE DENSITIES AND MAGNETIC FORM FACTORS. A.J.Freeman and R.E.Watson.
Phys. Rev., Vol. 118, No. 5, 1168-72 (June 1, 1960).

The effects of crystalline fields on 3d charge densities and magnetic form factors for transition metal ions are discussed on the basis of recent theoretical investigations augmented by an analysis of optical absorption data. It is shown that the crystalline field has two effects on the free ion 3d wave-functions and hence on their form factors as well: (1) a differentiation of "splitting" of the two types of cubic 3d functions by an expansion of the $t_{2g}(e_g)$ orbitals and a contraction of the $e_g(t_{2g})$ orbitals resulting in two different radial charge densities, and (2) a net expansion of the charge distribution from the free ion value. The magnetic form factors due to this "splitting" effect when calculated according to the methods of Weiss and Freeman show measurable deviations from the free atom results. A form factor for Mn^{2+} based on optical absorption data shows a large expansion of the 3d charge density, in agreement with the magnetic form factor measurements of Hastings, Elliott, and Corliss. This agreement, based on the use of theoretical $F^k(3d,3d)$ integrals, indicates that the well-known discrepancy between theoretical and experimental values of these integrals arises from the fact that the quantities obtained experimentally are not true $F^k(3d,3d)$ integrals. The crystalline potential due to an array of negative ion charge densities has been employed to discuss these various effects and their meaning with respect to a proper (essentially molecular) treatment.

539.2

9887 BAND STRUCTURE OF ALUMINUM. W.A.Harrison.
Phys. Rev., Vol. 118, No. 5, 1182-9 (June 1, 1960).

Calculations of the band energies at symmetry points in aluminium by Heine (Abstr. 9294 of 1957) are extended into the zone using the pseudopotential interpolation scheme in order to obtain constant-energy curves in the neighbourhood of the Fermi surface. In conjunction with this calculation, the lines of contact between various bands are found in detail. The de Haas–van Alphen effect, cyclotron-resonance effect, anomalous skin effect, and low-temperature specific heat are discussed in terms of these constant-energy curves and the results compared with experiment. It appears from this comparison that the geometry of the Fermi surface is given quite well by the band calculations, but that there is a discrepancy of a factor of order two between the derived and measured effective masses. A "single orthogonalized-plane-wave approximation" is compared with the more exact treatment and found to be a good starting approximation, suitable for semiquantitative treatment of the electronic structure.

539.2

9888 ELECTRONIC STRUCTURE OF POLYVALENT METALS. W.A.Harrison.
Phys. Rev., Vol. 118, No. 5, 1190-208 (June 1, 1960).

A single-orthogonalized-plane-wave approximation is defined and used to construct the Fermi surfaces for face-centred-cubic and body-centered-cubic metals of valence one through four and for hexagonal-close-packed metals of valence one through three. The de Haas–van Alphen effect, cyclotron-resonance effect, and anomalous skin effect are discussed in detail in terms of these surfaces and the deduced properties are compared with experiment where suitable experiments exist. In particular, earlier and equivalent comparisons for lead and for aluminium are reviewed, and detailed comparisons with existing experimental data on zinc and cadmium are made. It is found that the single-OPW approximation is in semiquantitative agreement with experiment in all of these cases, both as to the form of the Fermi surface and its associated effective masses. In conjunction with these studies, detailed descriptions of the apparent Fermi surfaces in zinc and cadmium are given. An extension of the

method to allow experimental determination of a more precise description of the band structure is discussed, and the generalization of the method to studies of alloys is outlined.

539.2

9889 BAND ENERGY SPECTRUM IN THE PRESENCE OF A MAGNETIC FIELD. G.E.Zil'berman.
Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1452-4 (Nov., 1959). In Russian.

Eigenfunctions (in the k-representation) are derived which describe the motion of an electron with an arbitrary dispersion law in a magnetic field, in the case of two energy bands (in particular of overlapping ones). The condition of applicability of the one-band approximation is deduced.

539.2

9890 EXPERIMENTAL PROOF OF THE EXISTENCE OF A NEW ELECTRONIC COMPLEX IN SILICON. J.R.Haynes.
Phys. Rev. Letters, Vol. 4, No. 7, 361-3 (April 1, 1960).

Recombination radiation from silicon crystals containing one group III or group V impurity was examined with a high resolution spectroscope at 25°K. In pure crystals there is one principal line due to recombination of excitons with emission of a transverse optical (TO) phonon. With the doped crystals two new very sharp lines appear, with intensity proportional to the impurity content; their energy difference is equal to the energy of the TO phonon. Several considerations indicate that the complex producing these lines is a hole bound to a positive donor ion by an electron pair bond (or an analogous complex with change of sign of the charges). The energy required to free an exciton from the complex is equal to the energy difference between the main exciton line and that of the new lines which does not involve phonon emission. L.Pincherle

539.2 : 536.48

9891 HYPERFINE COUPLING IN FERROMAGNETICS. R.G.Scurlock.
Physica, Vol. 24, Supplement, S156 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Using nuclear orientation techniques, some further experiments have been carried out to measure the hyperfine interaction in ferromagnetics. These were designed to study the relative s- and d-character of ferromagnetic electrons. Experiments have been performed with cobalt in cubic alloys where the effective field of the 3d electrons at the nucleus should average zero. The ferromagnetic samples were cooled to about 0.04°K and the ferromagnetic moments saturated by an external magnetic field. The nuclear orientation was measured by the intensity of the γ-rays emitted parallel and perpendicular to the magnetizing field, from 20 μC of Co^{60} present in the sample. Results of experiments using alloys of cobalt in iron and nickel are discussed with regard to the latest theories of ferromagnetism.

Defect Properties

539.2 : 541.12

9892 STATISTICAL FORMULATION OF CHEMICAL REACTIONS BETWEEN DEFECT PARTICLES IN CUBIC CRYSTAL LATTICES. A.Scholz.
Ann. Phys. (Leipzig), Ser. 7, Vol. 5, No. 7-8, 353-72 (1960). In German.

The kinetical equations for the defect reactions in cubic crystals are derived from probability considerations, the decisive magnitude being the probability of the presence of an impurity atom at a certain lattice place. The correlation of adjacent foreign ions is allowed for in the case of chemical reactions between defects. Detailed calculations are carried out for (1) the formation of vacancy pairs from isolated vacancies in NaCl-type crystals, and (2) for the chemical reaction $Ag_0^+ + S_G^- \rightleftharpoons [Ag_0^+ S_G^-]$ in Ag halides. F.Lachman

539.2 : 536.41 : 532.7

9893 CONTRIBUTIONS FROM THERMAL LATTICE DEFECTS TO THE EXPANSION OF SOLID AND LIQUID METALS. G Borelius.
Ark. Fys., Vol. 16, Paper 10, 119-28 (1959).

Experimental data for the thermal expansion of solid and liquid Au, Ag, Cu and Al is examined and discussed in terms of defect formation. Consistency is claimed for an interpretation involving vacancies and an unidentified type of primary defect. It is held that the structural part of the thermal expansion for the substances in their liquid state is due mainly to vacancy formation and that saturation occurs with respect to the primary defects. J.W.Leech

539.2

9894 VARLEY MECHANISM FOR DEFECT FORMATION IN ALKALI HALIDES. D.L.Dexter.
Phys. Rev., Vol. 118, No. 4, 934-5 (May 15, 1960).

The Varley mechanism (Abstr. 3265, 4180 of 1955) is examined, according to which Frenkel defects are produced in the halogen sublattice of alkali halides subsequent to multiple ionization of the halide ions. Arguments are presented to show that the lifetime of a positive halogen ion against recapture of electrons in orders of magnitude smaller than the ejection time of the halogen, and thus that the Varley mechanism is inoperative. The arguments may not be applicable for inner shells alone, but experimental evidence is adduced to eliminate this case.

539.2

9895 THE TEMPERATURE DEPENDENCE OF THE STRUCTURE OF POINT DEFECTS IN CUBIC CRYSTAL LATTICES. K.Fischer.
Z. Phys., Vol. 157, No. 2, 198-218 (1959). In German.

The free energy and the volume change associated with a vacancy in a rare gas lattice is calculated, assuming the model of Teworat (Abstr. 1326 of 1958) for the crystal and defect, in the harmonic and next higher approximation taking account of the nearest and next nearest neighbours.

539.2

9896 THEORY OF DISLOCATION CLIMB IN METALS. J.Lothe.
J. appl. Phys., Vol. 31, No. 6, 1077-87 (June, 1960).

An estimate of the climb motion of dislocation jogs is given, which takes into account the fact that dislocations are pipes of easy diffusion. The climb of dislocations under near-equilibrium conditions is then discussed. A new estimate is made of the jog concentration, for which vacancy equilibrium will be established along the entire dislocation. It is argued that the dislocation line tension is an important driving force both in high-temperature creep and in whisker dekinking. Under quench conditions it must be expected that a great number of jogs are nucleated at the nodes of the dislocation network.

539.2

9897 GENERATION OF DISLOCATIONS BY AN ELECTRIC FIELD IN MgO. E.Mendel and S.Weinig.
J. appl. Phys., Vol. 31, No. 4, 738-9 (April, 1960).

Suitably prepared MgO crystals, cleaved along (100) planes, were used to study the effect of an electric field on the morphology of ceramic crystals; it was observed that dislocation arrays were produced in the crystal surface. A possible alternative explanation of these observations in terms of local heating near the electric probe is considered, but it is concluded that heat alone could not account for the observed dislocation pattern after the application of the electric field. R.Bullough

539.2

9898 THE ACTIVATION ENERGY FOR CROSS SLIP OF A DISSOCIATED SCREW-DISLOCATION. H.Wolf.
Z. Naturforsch., Vol. 15a, No. 3, 180-93 (March, 1960). In German.

A linear relation is obtained between the activation energy for cross slip of a screw dislocation in a dislocation group and the logarithm of the applied shear stress for a given number (n) of dislocations in the group and a given stacking fault energy (γ) using a Peierl's model and a linear Kröner theory. The proportionality constant is only slightly dependent on n but varies markedly with γ. J.E.Caffyn

539.2

9899 DISLOCATIONS RENDERED VISIBLE BY SURFACE EVAPORATION IN NaCl CRYSTALS. H.Bethge and W.Keller.
Z. Naturforsch., Vol. 15a, No. 3, 271-2 (March, 1960). In German

The surface structure of specimens heated in high vacuum is investigated by a gold decorated replica technique in the electron microscope. J.E.Caffyn

539.2

9900 THE USE OF THERMAL CONDUCTIVITY MEASUREMENTS TO IDENTIFY THE LATTICE IMPERFECTIONS INTRODUCED IN A Cu–Zn ALLOY BY PLASTIC DEFORMATION. W.R.G.Kemp, P.G.Klemens and R.J.Tainsh.
Physica, Vol. 24, Supplement, S170 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The thermal and electrical conductivities were measured of specimens torsionally deformed and isochronally annealed to 250°C, 290°C and 400°C. Stored energy release and density and resistance changes of equivalent specimens have been measured by Clarebrough (Abstr. 10006 of 1954). While a large electrical resistance change and a large stored energy release occurred during the first annealing stage, the lattice thermal conductivity changed only slightly. During the second stage the lattice conductivity changed, indicating that the dislocation density was halved. There were also some indications that stacking faults were removed during that stage. During the final stage the remaining dislocations were removed, together with point defects producing a large lattice thermal resistance. This change is not accompanied by an appreciable density change. The point defects are probably vacancy clusters which are not removed by annealing, but come together to form larger holes. Dislocation density estimates from the lattice thermal conductivity are higher than estimates from stored energy and density changes, even using revised estimates of the scattering of phonons by dislocations. (Klemens, 1958).

539.2

9901 THE EFFECT OF POINT IMPERFECTIONS ON LATTICE CONDUCTION IN SOLIDS. R.Berman, P.T.Nettley, F.W.Sheard, A.N.Spencer, R.W.H.Stevenson and J.M.Ziman.
Proc. Roy. Soc. A, Vol. 253, 403-19 (Dec. 15, 1959).

The thermal conductivity of single crystals of LiF containing various relative concentrations of the isotopes Li^6 and Li^7 was measured between 10° and 90°K. An increase in thermal resistance with isotope concentration (up to 50% of either isotope) is observed, but the results at 30°K fit neither the formula of Klemens (Abstr. 2546 of 1956) nor the formula previously deduced for the limit of small isotope concentrations (Abstr. 6094 of 1957). In a new variational treatment a more general trial function is used and the contribution of the phonon–phonon N-processes is calculated explicitly. This gives results in good agreement with the present experiments and also with published observations on a wide range of crystals containing known concentrations of point imperfections.

539.2

9902 ON THE BEHAVIOUR OF LATTICE VACANCIES IN PURE METALS. E.Germagnoli and S.Granata.
Energia nucleare, Vol. 7, No. 5, 309-22 (May, 1960). In Italian.

The available experimental results concerning the production and the analysis of the behaviour of lattice vacancies in pure metals are reviewed: a vacancy is probably the simplest defect in solids but nevertheless the related properties are sometimes hard to interpret. It is thought that experiments performed under very simple conditions and involving a unique kind of defect may be useful in explaining some pecularities of radiation damage.

539.2 : 539.17

9903 THE ROLE OF VACANCIES AND DISLOCATIONS IN THE NUCLEATION AND GROWTH OF GAS BUBBLES IN IRRADIATED FISSILE MATERIAL.
G.W.Greenwood, A.J.E.Foreman and D.E.Rimmer.
J. nuclear Mater., Vol. 1, No. 4, 305-24 (Dec., 1959).

Recent experiments have shown that many samples of uranium irradiated at up to 600°C witout large temperature fluctuations do not swell by more than a few per cent, and electron microscope studies indicate that the fission product gases are contained at high pressures in bubbles of less than a micron in diameter. The existing theories of swelling are inapplicable to this situation for they assume that gas collects in large bubbles, probably nucleated on inclusions, and which grow by macroscopic plastic deformation of the material between them. It is shown in the present paper that fine scale bubbles are to be expected in reasonably pure material, the bubbles nucleating either homogeneously with a spacing less than a micron or on any nucleation sites that may exist on this or a finer scale. The dislocation lines and nodes should provide suitable nucleation sites as they have about the right spacing and their stress fields should attract the large inert gas atoms to form Cottrell atmospheres. The bubbles when once nucleated grow by a vacancy diffusion mechanism, the vacancies being created by the fission process. At temperatures above some value, which in certain cases may be as low as about 300°C, the influx of vacancies is sufficient to prevent the gas pressure in a bubble from exceeding the surface energy restraining force by more than an order of magnitude, in which case dislocation mechanisms of plastic deformation should not operate. If the sinks for point defects accept interstitials more readily than they do vacancies, an enhanced growth can occure at the lower temperatures due to condensation of the excess vacancies on to the bubbles.

539.2

9904 STRAIN SCATTERING BY VACANCIES AND IMPURITIES IN METALS. P.M.Lee and N.H.March.
Phys. Rev., Vol. 118, No. 1, 138-41 (April 1, 1960).

A simple model is proposed by means of which nearest neighbour displacements round a vacancy and an impurity in a metal may be taken into account in calculating excess resistivities. Using Tewordt's calculated nearest neighbour displacement for a vacancy in copper (Abstr. 1326 of 1958) an excess resistivity of 0.94 μ ohm cm per atomic % is obtained from the authors' model. The same model without strain yields 0.97 μ ohm cm. The case of silver impurities in copper is also considered and it is shown that a radial increase of ~3% in the nearest neighbour distance is sufficient to account entirely for the observed excess resistivity.

539.2

9905 PRELIMINARY RESULTS ON THE CREATION ENERGY OF A VACANCY IN SOLID ARGON.
G.Nardelli and A.Repanai.
Physica, Vol. 24, Supplement, S182-S183 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The energy needed to create a vacancy in solid argon has been calculated assuming an interaction potential of the form $Ar^{-12}-Br^{-6}$, with A and B taken from the work of Domb and Zucker (1956). The elastic relaxation of the 12 nearest neighbours of the vacancy has been found to be 0.37% of the interatomic spacing, while the distortion of the lattice at larger distances has been neglected. Considering the nearest neighbours as independent oscillators, the contribution of their zero point energy has been calculated: the work to create a vacancy is 7.5×10^{-2} eV. The variation of the vibrational entropy of the nearest neighbours has been evaluated in the same approximation (Abstr. 9237 of 1955). The concentration of vacancies in thermodynamical equilibrium is

$$n_v/N = e^{\Delta S/k}\, e^{-\Delta H/kT} = e^{\Delta S/k}\, e^{-0.075/kT}.$$

For T = 80°K, $\Delta S/k \cong 1.7$ and $n_v/N \cong 10^{-4}$.

539.2

9906 EFFECT OF PRESSURE ON THE SPECTRA OF COLOR CENTERS. R.A.Eppler and H.G.Drickamer.
J. chem. Phys., Vol. 32, No. 5, 1418-22 (May, 1960).

The effect of pressure on the spectra of certain colour centres produced in the alkali halides by X-irradiation was measured to pressures as high as 166 000 atm. For the F centre a shift to higher energies with increasing pressure is observed. The slope of the shift versus density is at least twice the value that would be predicted from Ivey's relation at low pressure, and decreases with increasing pressure. This indicates that the compressibility in the neighbourhood of the F centre is greater than in the bulk crystal, particularly at low pressure. For the M centre in LiCl a shift to higher energy with increasing pressure is observed, about one-fifth as great as the shift observed for the F centre.

539.2

9907 THE EFFECT OF AN ACTIVATOR ON THE STABILITY OF F-CENTRES. I.A.Parfianovich and E.I.Shuraleva.
Optika i Spektrosk., Vol. 7, No. 4, 518-23 (Oct., 1959). In Russian.

Optical decomposition (bleaching) of F-centres in pure NaCl crystals and NaCl activated at 680–760°C with nickel or copper was studied. Crystals were coloured photochemically at room temperature using X-rays from a tube with a tungsten anode working at 50 kV. Stability of the F-centres was lowered by the presence of an activator, or, to a smaller extent, by heating of the crystals. A.Tybulewicz

539.2

9908 THE EFFECT OF ELASTIC DEFORMATION, PRODUCED BY UNIAXIAL COMPRESSION OR TENSION, ON THE SPECTRA OF LOCAL ANISOTROPIC CENTRES IN A CUBIC LATTICE. I. METHOD. A.A.Kaplyanskii.
A.A.Kaplyanskii.
Optika i Spektrosk., Vol. 7, No. 5, 677-82 (Nov., 1959). In Russian.

Elastic uniaxial compression or extension of a cubic crystal removes "orientational degeneracy" of energy levels of anisotropic centres, oriented along G_n axes. This is true both for the ground and excited states of these centres. Such compression or extension should produce splitting of individual absorption or luminescence bands which are due to transitions between levels of the anisotropic centres. It is shown that splitting of such bands can give information from which the orientation of the anisotropic centres in the lattice and the nature of the oscillators, used to describe absorption and luminescence of these centres, can be found. A.Tybulewicz

539.2

9909 THE EFFECT OF ELASTIC DEFORMATION, PRODUCED BY UNIAXIAL COMPRESSION OR TENSION, ON THE SPECTRA OF LOCAL ANISOTROPIC CENTRES IN A CUBIC LATTICE. II. EXPERIMENTAL PART. A.A.Kaplyanskii.

Optika i Spektrosk., Vol. 7, No. 5, 683-90 (Nov., 1959). In Russian.

Reports an experimental verification of the predicted effect of elastic uniaxial deformation on the spectra of local centres in cubic crystals of fluorite, activated with rare earths, and in coloured crystals of LiF. Both absorption and luminescence spectra were recorded at 77°K in polarized light; observations were made at right angles to the axis of elastic deformation. The splitting effect, predicted theoretically in Pt I, was observed clearly only in the line luminescence spectra of $CaF_2 : Eu^{+++}$, $CaF_2 : Sm^{+++}$ and coloured LiF. Comparison of the experimentally observed splitting with theoretical predictions yielded orientation of the anisotropic centres of line luminescence in these crystals and the multipole-order of elementary radiators which are responsible for some of these lines. A.Tybulewicz

539.2

9910 LOW-TEMPERATURE PROPERTIES OF H, V, AND F CENTERS IN KCl AND KBr. J.Cape and G.Jacobs.

Phys. Rev., Vol. 118, No. 4, 946-9 (May 15, 1960).

KCl and KBr crystals were exposed to X-rays at 10°K. The optical absorption produced by this irradiation and the changes in optical absorption produced by subsequent annealing at higher temperatures were measured. The temperatures at which changes in optical absorption occurred were correlated with the temperatures at which free electrical charge appeared, and thermoluminescence was observed. The absorption band at 345 mμ, in KCl, which has been named the H-band, is shown to result from the superposition of two or more bands, one of which is the absorption band due to self-trapped holes. In KCl, the self-trapped hole band bleaches thermally at 43°K with a release of free electrical charge. H-centres disappear at 56°K with a release of free charge. The optical absorption band of the H-centre is shown to have its maximum at 335 mμ. In KBr, the thermal release of free charge at 30°K is attributed to the disappearance of H-centres. No charge burst was observed in KBr which may be attributed to the destruction of self-trapped holes.

539.2

9911 COLLOIDS IN ADDITIVELY COLORED SODIUM CHLORIDE. H.W.Etzel.

Phys. Rev., Vol. 118, No. 5, 1150-3 (June 1, 1960).

Both natural and synthetic single crystals were additively coloured by heating in Na vapour and by injecting electrons from a point cathode. Subsequent irradiation with ultraviolet light and heating of the synthetic crystals produced an absorbing type colloid throughout the crystal. The same treatment applied to the natural crystals produced F-centres throughout the bulk of the crystal and absorbing type colloid specks at localized points in the crystal. In the synthetic crystals, the formation of these colloids is shown to be related to the presence of hydroxyl ions in the crystals prior to coloration. In the natural crystal, the formation of such colloids is dependent upon the presence of small occlusions of water distributed randomly in the crystal prior to coloration.

539.2

9912 THERMAL EQUILIBRIUM OF COLOR CENTERS IN DOPED KCl CRYSTALS.

P.Camagni, S.Ceresara and G.Chiarotti.

Phys. Rev., Vol. 118, No. 5, 1226-8 (June 1, 1960).

In additively coloured crystals of KCl:Sr a thermal reaction between F and Z_2 centres is observed. The reaction is reversible and approaches equilibrium in a few hours in the range of temperatures between 70° and 170°C. The equilibrium value of the ratio between the concentrations of F and Z_2 centres, (x_F/x_{Z_2}), does not depend upon the total amount of coloration nor upon the past history of the crystal, and for a given impurity content is a function only of temperature. For crystals containing 2.5×10^{-4} molar fraction of Sr, the experimental points fit the equation:

$$x_F/x_{Z_2} = 0.8 \times 10^{-4} \exp(-0.28/kT), \qquad kT \text{ in eV.}$$

A comparison of the latter empirical equation with those that can be derived through the application of the mass-action law to some specific models of the $F \rightleftarrows Z_2$ conversion is discussed.

539.2

9913 BLEACHING OF COLLOIDAL SILVER IN SILVER CHLORIDE. P.Stiptitz.

Z. wiss Photogr., Vol. 53, No. 10-12, 201-8 (1959). In German.

Colloidal Ag, produced by an impulse technique inside an AgCl crystal, was optically bleached by irradiation with light between 540 and 650 mμ. In the bleaching process, Ag is transferred from the site under irradiation to other sites. It was difficult or impossible to bleach colloidal Ag at lattice defects, no bleaching action occurred at the surface. J.Franks

539.2

9914 A METHOD FOR THE DETERMINATION OF THE IMPURITY DISTRIBUTION IN A SEMI-INFINITE SOLID. R.Engiman.

Physica, Vol. 24, Supplement, S179 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The rate of transport of impurities across the boundaries of a solid can be measured experimentally. It is shown how the knowledge of this transport-rate as function of the time can be used to find the original distribution of impurities in the solid. The same method may be applied to other diffusion processes.

539.2

9915 THE DIFFUSION OF COPPER INTO AlSb. R.H.Wieber, H.C.Gorton and C.S.Peet.

J. appl. Phys., Vol. 31, No. 3, 608 (March, 1960).

The rapid diffusion of copper into AlSb was studied in the range 150°-500°C by radioactive tracer techniques. A value of D_0 of 3.5×10^{-3} cm² sec⁻¹ and an activation energy of 0.36 eV was obtained. D.Walsh

539.2

9916 DIFFUSION OF CADMIUM IN PURE AND CADMIUM DOPED AgBr. J.E.Hanlon.

J. chem. Phys., Vol. 32, No. 5, 1492-501, (May, 1960).

The diffusion of Cd in pure AgBr and dilute AgBr-$CdBr_2$ solid solutions was measured by a tracer technique using carrier-free Cd^{109}. It was necessary to use the extremely high specific activity carrier-free isotope because the diffusion of Cd in AgBr depends sensitively on impurity concentration. The data support Lidiard's theory for the diffusion of divalent impurities in monovalent ionic crystals. From the diffusion rates in the pure material, it is possible to calculate the association energy ΔG of $Cd^{++}Ag$ vacancy complexes. The value of ΔG extrapolated to 0°K is estimated to be 0.21 ± 0.04 eV. The observed concentration dependence of Cd diffusion in doped samples can be explained only if the mobility of complexes is assumed to have a strong concentration dependence. This interpretation suggests that a reappraisal of the analysis of previous electrical conductivity and thermoelectric power doping experiments, in which the mobility was assumed to be concentration independent, would be desirable.

539.2

9917 DIFFUSION AND IONIC CONDUCTIVITY IN CESIUM BROMIDE AND CESIUM IODIDE. D.W.Lynch.

Phys. Rev., Vol. 118, No. 2, 468-73 (April 15, 1960).

The diffusion coefficients of the constituent ions were measured in CsBr and CsI crystals between 300° and 550°C by means of radioactive tracers and were compared with electrical conductivity measurements. Approximate satisfaction of the Nernst–Einstein equation indicates that the conductivity is nearly completely ionic and the diffusion measurements show that the halogen ion defects are the more mobile. Attempts to identify the mechanisms for ionic transport by means of the Bardeen–Herring correlation factor are discussed. Schottky defects seem likely but the assumption of an additional mechanism for cationic transport is required. If Schottky defects are predominant their formation enthalpies are 2.0 and 1.9 eV in CsBr and CsI respectively, and the activation enthalpies

for halogen vacancy motion are 0.27 and 0.3 eV respectively, while the caesium vacancy activation enthalpy is about 0.58 eV for both salts.

539.2

9918 DIFFUSION OF CADMIUM AND ZINC IN GALLIUM ARSENIDE. B.Goldstein.
Phys. Rev., Vol. 118, No. 4, 1024-7 (May 15, 1960).

The diffusion of Cd and Zn in GaAs was studied by using radioactive isotopes of these elements as tracers. The diffusion of Cd follows the correct solution to the diffusion equation and its temperature dependence is of the customary form, $D = D_0 \exp(-E/kT)$ where E, the activation energy, is 2.43 eV and D_0 is 0.05 cm^2/sec. The diffusion of Zn from the vapour cannot, however, be described in terms of a single diffusion constant. The penetration curves decrease much more sharply than they theoretically should. Hall measurements indicate that all the Zn is substitutional and that it forms an impurity conduction band merging with the valence band. When Zn diffuses from a thin electroplated layer of radio-zinc, then the penetration profiles do correspond to the proper solution to the diffusion equation. The diffusion constants so determined have the usual temperature dependence given by $D = D_0 \exp(-E/kT)$, where D_0 is 15 cm^2/sec and E is the same as that found for Cd. From the work reported here and that of others, it is suggested that the diffusion of Cd and Zn in GaAs proceeds via vacancy migration within the gallium sublattice.

539.2

9919 MECHANISMS OF VOLUME SELF-DIFFUSION IN α-Fe AND γ-Fe. C.J.Meechan.
Phys. Rev. Letters, Vol. 4, No. 6, 284-6 (March 15, 1960).

Sintering techniques (Abstr. 7527 of 1950), were used to obtain the diffusion rates of Fe in α-Fe(b.c.c.) and γ-Fe(f.c.c.) at 885° and 935°C, respectively. The values determined were $D_{885} < 6 \times 10^{-14}$ cm^2/sec (b.c.c.); $D_{935} = 3.5 \times 10^{-13}$ cm^2/sec (f.c.c.). In contrast to these results, radioactive tracer studies show that D in α-Fe is approximately 400 times larger than D in γ-Fe, near the transition temperature. It is concluded that the large change in D is caused by a change in the dominant diffusion mechanism. A change from 4-atom ring mechanism in b.c.c. Fe to a vacancy mechanism in f.c.c. Fe is suggested. R.F.Peart

539.2

9920 THE DIFFUSION COEFFICIENT OF ZINC IN INDIUM ANTIMONIDE. K.F.Hulme and J.E.Kemp.
J. Phys. Chem. Solids, Vol. 10, No. 4, 335-7 (Aug., 1959).

By diffusing zinc from the vapour phase into differently doped samples of n-type InSb (tellurium doped) and subsequently finding the depth of the p—n junction using a thermoelectric probe on a bevelled face, the diffusion coefficient of zinc in InSb was measured. The authors conclude that the temperature variation of the diffusion coefficient follows the usual law, $D = D_0 \exp(-E/RT)$, and find $D_0 = 1.6 \times 10^4$ cm^2/sec with an activation energy $E = 53 \pm 6$ kcal/mole (2.3 ± 0.3 eV). This is in harmony with one of two sets of results for self-diffusion in InSb. I.Cooke

539.2

9921 RADIATION DAMAGE IN CRYSTALS. L.Crabs, J.Debaisieux, D.Apers and P.C.Capron.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 9, 891-908 (1959).

The total number of atoms displaced and replaced in a crystal under neutron bombardment is calculated, on the assumptions that only elastic collisions with stationary atoms occur, and that all atoms are of equal mass. Comparison with experiment shows that this theory predicts too few displacements. J.Franks

539.2

9922 RANGE OF RADIATION INDUCED PRIMARY KNOCK-ONS IN THE HARD CORE APPROXIMATION. D.K.Holmes and G.Leibfried.
J. appl. Phys., Vol. 31, No. 6, 1046-56 (June, 1960).

The slowing down of a primary displaced atom of high energy in a solid is investigated in detail. Physically interesting quantities, such as the total distance travelled and the vector distance to the end of the path, are discussed in terms of certain averages for hard core potentials with general dependence of the core radius on energy. These averages are explicitly calculated for a screened Coulomb potential for the purpose of comparison with experimental ranges observed in different metals. Theoretical values for the range can be derived. Comparison with the experimental data gives a value for the screening radius of the interaction potential which is about twice the value originally suggested by N.Bohr.

539.2

9923 DARK BLUE RING DEVELOPED BY ELECTRON BOMBARDMENT IN ROCK SALT. S.Yoshida and T.Ikeda.
Nature (London), Vol. 185, 755-6 (March 12, 1960).

539.2

9924 STORED ENERGY EXPERIMENT IN ELECTRON IRRADIATED PURE COPPER. C.J Meechan, A.Sosin and R.M.Stern.
Physica, Vol. 24, Supplement, S178 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: See also Abstr. 5173 of 1959. A cryostat permitting the irradiation of thin copper specimens at liquid helium temperature with the Van de Graaff accelerator at Atomics International is described. It is possible to perform annealing and calorimetric measurements subsequent to irradiation in the cryostat without disturbing the samples. The energy release in the irradiated sample during annealing is measured by difference thermometry between the sample and an adjacent dummy having the identical history prior to irradiation but shielded from the electron beam. An additional calibration experiment is described which provided the determination of the sensitivity of the measuring instruments. The measurement of the stored energy released during the annealing of an irradiated sample suggested the nature of the damage induced by the irradiation. The discontinuous release of energy simultaneous with the annealing peak in the resistivity can be interpreted as being due to defects having a unique activation energy. Initial results only indicate a lower limit for the stored energy of Frenkel defects of 1.5 eV/pair taking the resistivity of 1½ defects as 4 μohm cm.

539.2

9925 IONIZATION EFFECTS PRODUCED IN DIAMONDS SUBJECTED TO MONO-ENERGETIC β-RAY BOMBARDMENT. P.J.Kennedy.
Proc. Roy. Soc. A, Vol. 253, 37-51 (Nov. 17, 1959).

The ionization produced within diamond specimens by the passage of high-energy β-rays was investigated using the methods of conduction pulse counting, and a new technique was developed to enable pulse-height spectra to be taken, rapidly and in quick succession, under widely different experimental conditions. It is shown that only a small proportion of the incident β-rays may dissipate their total energy within the specimen and that pulse-height spectra can be interpreted successfully only when a conduction pulse is related to the energy lost by the electron producing it. Under conditions of saturation field strength and low crystal polarization, the conduction pulse magnitude is proportional to the energy dissipated. The mean value of energy per ion pair is thus independent of the primary electron energy and the experimental value of 20 eV is shown to be remarkably consistent between diamond specimens. This value differs from the previously accepted value of 10 eV and, if used in preference to 10 eV, removes many apparent anomalies from previously published work. A theory is outlined in which it is proposed that the degradation of the primary electron energy takes place principally by interaction with the valence electrons of the crystal. The mean energy per ion pair depends, therefore, not only on the width of the forbidden gap in the solid, as previously suggested, but also on the width of the valence band and particularly on the position of the maximum in the density of states curve within the valence band. The available data for diamond suggest a value of approximately 18 eV for the mean ionization energy. This value is consistent with the experimental value from the maximum pulse height under saturation conditions. The finite breadth of the pulse spectra, however, can be explained only by some charge-reducing process occurring after the total dissipation of the incident energy. The process is tentatively linked with the scintillation response of the diamond crystal. Finally, criteria are suggested by which the conduction pulse response of various solids may be predicted.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

539.2 : 537.3

9926 ANISOTROPIC CONDUCTION IN SOLIDS NEAR SURFACES. P.J.Price.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 152-7 (April, 1960).

A reduction in the electrical conductivity of a solid results from "diffuse" reflection of electrons from the surfaces. The effect occurs for specular reflection also, if the operative electron-energy surfaces are not spherical. A theory of the latter case is given here. The average conductivity of a thin crystal tends to a finite limit (rather than zero) as the thickness tends to zero. The Hall effect for the same circumstances is also treated.

539.2 : 537.3

9927 SIZE EFFECTS FOR CONDUCTION IN THIN BISMUTH CRYSTALS. A.N.Friedman and S.H.Koenig.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 158-62 (April, 1960).

The size dependence of the electrical conductivity, and preliminary results for galvanomagnetic effects, in thin, single crystals of high-purity bismuth at 4.2°K are reported for a range of thicknesses comparable to the electron mean free path. The results, when interpreted according to the theory of Ham and Mattis (Abstr. 9953 of 1960) and of Price (see preceding abstract), show that the scattering of electrons by the surface is specular, and confirm the novel predictions of the theory for the case of specular reflection and anisotropic surfaces of constant energy.

539.2 : 537.3

9928 CONDUCTIVITY AND HALL CONSTANTS. X. THE DETECTION OF CONSTITUTION AND CLOSENESS OF MIXING. W.Köster.

Z. Naturforsch., Vol. 14a, No. 2, 200-3 (Feb., 1959). In German.

The measurement of Hall constant is used to monitor the free electron concentration of alloys of varying concentration of different pairs of metals, and thus to derive information about the electronic behaviour of the alloy. C.A.Hogarth

539.2 : 537.3

9929 THE THEORY OF THE RESIDUAL RESISTANCE OF COPPER. J.M.Ziman.

Proc. Roy. Soc. A, Vol. 252, 63-79 (July 7, 1959).

Cohen and Heine (1958) have suggested that the addition of impurities to Cu drives the Fermi surface out of contact with the zone boundary. Since the scattering of electrons by impurities is sensitive to the form of the wave function, and to the density of states, both of which depend on the nearness of the electron wave vector to the zone boundary, there should be anomalies in the transport properties. For example, the function σ (E) (conductivity as a function of energy), should have a discontinuity of slope at the point where the energy surfaces just break contact. An attempt is made to calculate σ (E), using a simple heuristic form of electron wave function, and allowing for the strong directional anisotropy of the scattering by a screened Coulomb potential. It is shown that there could be a small resistance minimum of the sort observed in some alloys of Cu, but the associated anomaly in the thermopower comes out with the wrong sign. The experimental properties of the resistance minimum are discussed in the light of this theory, and a programme of further experimental and theoretical research is proposed.

539.2 : 537.3

9930 THE ELECTRICAL RESISTIVITY OF A PHASE OF GALLIUM UNSTABLE AT ATMOSPHERIC PRESSURE. L.Bosio, A.Defrain and I.Epelboin.

C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2553-5 (April 4, 1960). In French.

Electrical evidence for the occurence of a new phase of gallium, which is denser than gallium I, is presented. This new phase is formed at −16.3°C when the supercooled metal is allowed to heat up, and identified with gallium II which is stable above 12 050 kg cm^{-2}. The anisotropy in the electrical resistance of gallium II is less marked than that in gallium I. D.J.Oliver

539.2 : 537.3

9931 PROPERTIES OF GREY TIN AT LOW TEMPERATURES. R.A.Hein and R.L.Falge, Jr.

Physica, Vol. 24, Supplement, S176 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The electrical resistance of a grey tin sample (irregularly shaped lump of the order of 10 mm^3 × × 10 mm) has been measured from 283°K down to 0.1°K. While the data in the intrinsic range yield a value of 0.068 eV for the energy gap, in fair agreement with published results, a sudden but finite decrease in the resistance occurred at 3.7°K indicating the presence of white tin inclusions. The resistance remained constant at this new value down to 1.3°K. After demagnetization the resistance was somewhat lower (of the order of 10%) and remained constant from 0.1°K to 0.22°K then increased gradually with temperature and attained its previous constant value about 1.0°K. The ballistic susceptibility of a specimen, consisting of 5 lumps of grey tin, failed to indicate any magnetic transitions within the temperature range 4.2°K to 0.1°K.

539.2 : 537.3

9932 MEASUREMENT OF THE RESISTANCE OF HIGH PURITY TIN AT HELIUM TEMPERATURES. V.B.Zernov and Yu.V.Sharvin.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1038-45 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36 (9), No. 4, 737-41 (Oct., 1959).

The resistance of a number of single crystals of tin of various purity was measured. The resistance was deduced from the moment of the forces acting on the specimen in a rotating magnetic field. The anisotropy and temperature dependence of the resistance between 4.2 and 3.73°K was measured and the residual resistance determined. For the purest specimen the residual resistance was about 3.7×10^{-11} ohm cm, which corresponds to an electron mean free path of about 3 mm.

539.2 : 537.3

9933 ELECTRICAL CONDUCTIVITY OF FERROMAGNETIC METALS AT LOW TEMPERATURES. II. E.A.Turov.

Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 203-13 (1958). In Russian.

For Pt I, see Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 19, 474 (1955). A phenomenological examination of the relation between electron conductivity and ferromagnons is carried out. The problem of the electrical resistance of ferromagnetics at low temperatures is investigated using previously obtained experimental data (see Abstr. 3251 of 1957). K.N.R.Taylor

539.2 : 537.3 : 539.3

9934 INFLUENCE OF COLD WORK ON THE RESISTIVITY OF DILUTE COPPER ALLOYS. P.G.Klemens, R.J.Tainsh and G.K.White.

Phys. Rev., Vol. 118, No. 3, 654-5 (May 1, 1960).

Measurements are reported of the residual electrical resistivity of Cu plus 1 at.% Sb alloy which had been cast and rolled. A large increase was observed on annealing, as noted by Kropschot, Garber and Blatt (Abstr. 5672 of 1959). However, metallographic examination and the smallness of the change observed on subsequent rerolling suggest that their proposed mechanism of "migration" during cold work plays a much smaller part than lack of homogeneity in the cast alloy.

539.2 : 537.3

9935 PROBLEMS OF CURRENTS IN MAGNETIC FIELDS. T.H.K.Barron and D.K.C.MacDonald.

Physica, Vol. 24, Supplement, S102-S108 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). The effects of geometry and of size on apparent magnetoresistance are discussed. The problem of specimen geometry is pointed out to be one of some difficulty. An improved theory is given for the resistance of a thin plate in a longitudinal field. L.Mackinnon

539.2 : 537.3

9936 MAGNETORESISTANCE OF METALS IN HIGH MAGNETIC FIELDS. B.Lüthi.

Physica, Vol. 24, Supplement, S173 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Magnetoresistance measurements in magnetic fields up to 200 000 Oe have been carried out on

metals at temperatures 4°K and 80°K. These measurements represent a considerable extension of the available data in the Justi–Kohler diagram. Comparison with existing measurements and with Kohler's rule are made. The agreement with recent theories is discussed.

539.2 : 537.3

9937 INFLUENCE OF A MAGNETIC FIELD ON THE ELECTRICAL RESISTANCE OF THIN FERROMAGNETIC LAYERS AT LOW TEMPERATURES. A.A.Hirsch.
Physica, Vol. 25, No. 7, 581-9 (July, 1959).

For earlier work, see Abstr. 9938 of 1960. An interpretation is suggested for the hysteresis loops of magnetoresistance in thin layers of ferromagnetic metals at low temperatures, assuming metallic conduction within the grains composing the layers. The calculation of the loops is based on Akulov's law of anisotropy, taking into consideration a magnetic anisotropy which is made up of a uniaxial and a cubic magneto-crystalline component. For some orientations of the grains the magnetization loops are double. It is supposed that in the case of this type of double-loop, thermal fluctuations contribute to a process of large magnetization jumps. On the basis of this process a possible explanation is given for the Van Itterbeek-Dupré formula which describes the temperature variations of the coercive field of nickel layers. The results are discussed in connection with the measurements carried out by Van Itterbeek and co-workers on magnetoresistance of thin layers and by Weil and Conte on magnetization loops of thin ferromagnetic layers at low temperatures.

539.2 : 537.3

9938 ELECTRICAL RESISTIVITY OF THIN FERROMAGNETIC LAYERS AT LOW TEMPERATURES. A.A.Hirsch.
Physica, Vol. 24, Supplement, S173 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: An interpretation is suggested for the hysteresis loops of magneto-resistance in thin layers of ferromagnetic metal at low temperatures, assuming metallic conduction within the grains composing the layer. The magnetoresistance derived forms a loop that accounts for the experimental results (Abstr. 6645 of 1956) and it is therefore concluded that the mechanism of electric conductivity is probably not dependent on intercrystalline barrier effects. The various shapes of the loops are calculated, taking into consideration the orientation of the current in the grain relative to direction of spontaneous magnetization, the magnetic shape anisotropy and the magnetocrystalline anisotropy. It is assumed that the shape anisotropy changes appreciably with reduction of temperature, due to splitting up of grains bonded to the support. This assumption can also explain the thermal changes of electric resistance in thin metal layers, as determined by d.c. and high frequency a.c. measurements.

539.2 : 537.3

9939 THE ANISOTROPY OF MAGNETORESISTANCE AND THE TOPOLOGY OF THE FERMI SURFACES OF METALS. N.E.Alekseevskii and Yu.P.Gaidukov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 672-7 (Sept., 1959).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 481-4 (March, 1960).

The anisotropy was studied for single crystals of Ag, Au, Cu, Sn, Pb, Tl and Ga. Stereographic projections of the singular field directions were constructed; some aspects of the topology of the Fermi surface are discussed on the basis of these projections.

539.2 : 537.3

9940 MAGNETORESISTANCE OF COPPER. J.de Launay, R.L.Dolecek and R.T.Webber.
Physica, Vol. 24, Supplement, S172 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The magnetoresistance of copper has been measured at 297°K, 78°K, and 4.2°K. In a transverse field of 100 kG at room temperature the resistance increased about ¼% and within experimental error was a quadratic function of the applied magnetic field. At the low temperatures the field dependence of the transverse magnetoresistance is considerably less than quadratic and approaches linearity at high fields. Considerable temperature dependence for Kohler's rule was found, as well as some deviations attributed to differences in sample purity. Saturation of the longitudinal magnetoresistance at high fields was observed at 4.2°K. The change in longitudinal resistance for saturation is of the order of the initial resistance in zero field and was found to be independent of temperature for the range 2.0 to 4.2°K and of measuring current for the range 0.1 to 2.0 A. The ratio of the transverse to the longitudinal magnetoresistance of a specimen was found to be a linear function of the applied field.

539.2 : 537.3

9941 MAGNETORESISTANCE AND SIZE-EFFECTS IN INDIUM. J.L.Olsen.
Physica, Vol. 24, Supplement, S172 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Longitudinal and transverse magnetoresistance measurements on pure indium at helium temperatures have been extended to values of H/r ca. 10 times greater than previously investigated. (H is the magnetic field, and r is the reduced resistivity ρ_T/ρ_θ). There is no sign of a break-down of saturation such as that observed in aluminium. In thin specimens size effects corresponding to those found by MacDonald and by Chambers (Abstr. 3223 of 1949, 7256 of 1950) in sodium were observed. For thin specimens, too, a size dependent breakdown of Matthiesen's rule was observed. The resistivity change with temperature was greater in the thin than in the thick specimens.

539.2 : 537.3

9942 THE ELECTRICAL RESISTANCE AND THE MAGNETO-RESISTANCE OF DILUTE ALLOYS OF GOLD WITH RHODIUM, PALLADIUM AND MOLYBDENIUM AND OF SILVER WITH PALLADIUM AT LOW TEMPERATURES. B.Knook.
Physica, Vol. 24, Supplement, S174-S175 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: In continuation of a systematic investigation on the electrical properties of alloys of noble metals and transition metals, measurements of the electrical resistance and magnetoresistance of dilute alloys of gold and silver with elements of the second series of transition metals are reported. Wires of Au–Rh (0.05, 0.1, 0.4 and 0.8 at. % Rh) and Au–Pd (0.05, 0.1, 0.4 and 0.8 at. % Pd) show a minimum only in the resistance temperature curve. No maximum is found. At low temperatures there are deviations from the Kohler diagram. For some wires of Ag–Pd (0.03, 0.06 and 0.34 at. % Pd) the resistance has a minimum at temperatures of liquid helium, for other wires (0.2 and 1.43 at. %) the resistance is independent of temperature in this temperature region. Also measurements on thin, unannealed and annealed strips of Ag–Pd (0.18, 1.0, 3.7, 5.2 and 12.5 at. % Pd) and on strips of Au–Mo are reported. In liquid helium the resistance of the unannealed Ag–Pd strips does not depend on temperature. The resistance of Au–Mo strips shows a rather deep minimum.

539.2 : 537.3

9943 MAGNETORESISTANCE OF SOME NICKEL ALLOYS. H.C.Van Elst.
Physica, Vol. 24, Supplement, S 173 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The resistance of about 40 nickel alloys was measured in longitudinal magnetic fields ($\rho_{\shortparallel}$) and transversal magnetic fields ($\rho_{\perp}$) up to 20 kOe at room temperature, liquid nitrogen temperatures and liquid hydrogen temperatures. The spontaneous (maximum) relative magneto-resistance anisotropy $2(\rho_{\shortparallel} - \rho_{\perp})\ (\rho_{\shortparallel} + \rho_{\perp})H = 0$ was determined from these measurements by extrapolation from fields in which technical saturation was realized to zero magnetic field. The alloying component of nickel was mostly a non-ferromagnetic metal (Cu, Pd, Cr, Si, Sn, Al, V, W, Mn, Mo, Zn). In general the effect was of the order of 0.1–1%, hence smaller by one order of magnitude compared with the alloys with only ferromagnetic components. In some cases the above defined resistance anisotropy showed a negative sign. Plastic deformation seemed to increase the effect slightly. Qualitative explanations of the effect have been given by Smit andVonsovskii and Rodionov (Abstr. 3673 of 1951). The spontaneous Hall coefficients of some of these alloys have been determined by Smit and Vonsovskii and Rodionov of 1954) at the same temperatures. The elastoresistance of some of the alloys was also measured at these temperatures.

539.2 : 537.3

9944 ISOTHERMAL GALVANOMAGNETIC EFFECTS IN ZINC AT LOW TEMPERATURES.
S.A.Ali, C.G.Grenier and J.M.Reynolds.
Physica, Vol. 24, Supplement, S174 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Isothermal galvanomagnetic properties have been studied in metal single crystals of zinc in

transverse magnetic fields up to 11 kG and to 1.6°K. By subtracting the monotonic increase in resistance, oscillations are found which are periodic in the reciprocal of the magnetic field. The system of double peaks as observed in the Hall effect is found present in these oscillations, too, with similar characteristics. The monotonic rise of magneto-resistance seems to have different characteristics for low and high fields. At low fields it possesses a positive quadratic term and at high fields a negative (probably quadratic) term with the point of inflection at about 4.5 kG which corresponds about to the field at which the Hall effect changes in sign. The average value of $\beta_Z/E_0 = 6.3 \times 10^{-5}\ G^{-1}$ is derived from the data. The lowering of temperature from 4.2 to 1.8°K is found to cause a shift in the oscillation peaks to lower field values and an overall decrease in the amplitude with the increase of the prominence of the double peaks. Anisotropy measurements show minimum magnetoresistance for orientation at right angles to the hexagonal axis in agreement with Alers and Borovik (Abstr. 2824, 5113 of 1956).

539.2 : 537.3

9945 GALVANOMAGNETIC PHENOMENA IN INDIUM AND ALUMINIUM. E.S.Borovik and V.G.Volotskaya.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 261-2 (Jan., 1960). In Russian.

Experiments, conducted on an In single crystal and polycrystalline Al in a magnetic field, H, perpendicular to the current, showed that the Hall constant was isotropic and, in the 10 000-28 000 Oe range, independent of H. The E_y/E_x ratio (where E_y is the Hall field, E_x the field due to the current) increased linearly with H, reaching the value of 20 at H = 28 000 Oe. Only slight anisotropy of electrical resistance, r, was observed, the maximum deviation from the mean value of r not exceeding 25%; at high H, r approached a limiting value. Similar results were obtained for Al; the values of E_y/E_x, obtained for this metal at high H, differed considerably from those, quoted by Lüthi and Olsen (Abstr. 5215 of 1956) and regarded by the present authors as erroneous. The experimental results obtained were taken to indicate that both In and Al are metals characterized by a closed Fermi surface and unequal numbers of holes and electrons. M.H.Sloboda

539.2 : 537.3

9946 APPARATUS FOR THE MEASUREMENT OF THE HALL EFFECT IN POWDERED SOLIDS. P.Bothorel.

C.R.Acad. Sci. (Paris), Vol. 250, No. 17, 2892-4 (April 25, 1960). In French.

An arrangement for maintaining a powdered specimen at constant hydrostatic pressure and for measuring resistivity, magnetoresistance, and Hall constant is described. The pressure may be varied and the consequent change of electrical characteristics determined. The apparatus is especially suitable for use with graphite. C.A.Hogarth

539.2 : 537.3

9947 ELECTRON RELAXATION TIME IN A HIGH-FREQUENCY ELECTROMAGNETIC FIELD AND THE SURFACE IMPEDANCE OF A METAL. R.N.Gurzhi and M.Ya.Azbel.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 524-8 (Feb., 1960). In Russian.

The effect of quantization of the electromagnetic field and electron orbits in a constant magnetic field on the relaxation time of electrons in a metal due to electron–phonon interactions and also on the surface impedance of the metal is studied. The complete frequency region (normal skin effect, anomalous skin effect, infrared region) up to the internal photoeffect limit has been investigated. It is shown that quantization of the orbits is significant only in the anomalous skin effect region for $\omega \sim \Omega \gtrsim kT/\hbar$ (Ω is the cyclotron frequency, T the temperature). Quantization of the electromagnetic field is always important in the infrared region and for the anomalous skin effect in a constant magnetic field (throughout the whole magnetic field region for $\omega \sim \Omega$ and only for cyclotron resonance when $\omega \gg \Omega$).

539.2 : 537.3

9948 TRANSPORT NUMBER IN SOLID CESIUM BROMIDE. N.Laurance.

Phys. Rev., Vol. 118, No. 4, 988-9 (May 15, 1960).

The transport number of CsBr single crystals was measured over the temperature range 350° to 450° C by the method of Tubandt (1932). No temperature dependence is observed, and the average value of the cation transport number is 0.49 ± 0.05. A preferential growth phenomenon is described, and its possible interference with the measurement is discussed. It is estimated that the true cation transport number may be as low as 0.3 because of this phenomenon.

539.2 : 537.3

9949 GAMMA-RAY INDUCED CONDUCTIVITY IN POLYETHYLENE COAXIAL CABLE. K.Yahagi and A.Danno.

J. appl. Phys., Vol. 31, No. 4, 734 (April, 1960).

Changes in the electrical conductivity of polyethylene coaxial cable during Co^{60} gamma ray irradiation are reported. The dosage rate was up to 10^8 r/hr and the relation between induced current I and dose rate R was $I \propto R^{\Delta}$ with Δ about 0.68. This value is less than that of 0.75 found in a similar experiment by Mayburg and Laurence (Abstr. 8858 of 1952) and the smaller value is assumed to be due to the predominence of bimolecular recombination between free electrons and positive ions over the trapping of electrons by trapping centres. In contrast to Mayburg and Laurence, the authors suppose the conduction process to be electronic rather than ionic. R.G.C.Arridge

Semiconductors

539.2 : 537.311

9950 PHENOMENA [OBSERVED] IN HETEROGENEOUS SEMICONDUCTORS. G.Pataki and P.Sebeni.

Acta phys. Hungar., Vol. 10, No. 3, 301-4 (1959). In Russian.

An asymmetry was observed in the magnetoresistance of heterogeneous semiconductors. The experimental results are compared with theory and the agreement found to be satisfactory. K.N.R.Taylor

539.2 : 537.311

9951 VARIATION OF THE ABSOLUTE ABSORPTION COEFFICIENT OF THIN FILMS OF SEMICONDUCTORS AS A FUNCTION OF THICKNESS. G.Perny, M.Brendle and R.Lorang.

C.R.Acad. Sci. (Paris), Vol. 250, No. 9, 1618-20 (Feb. 29, 1960). In French.

For thin films of semiconductors in the thickness range 1000 - 6000 A, the absorption coefficient K varies with thickness x as a hyperbolic law. The product Kx varies (within the same range of x), linearly with x, except for a strong anomaly near 1000 A. Results are plotted for thin films of AgI. C.A.Hogarth

539.2 : 537.311

9952 TWO MECHANISMS OF THE MOVEMENT OF FREE CHARGES. A.F.Ioffe.

Fiz. tverdogo Tela, Vol. 1, No. 1, 157-9 (1959). In Russian.

Objections are formulated to applying the contemporary concepts of the nature of the movement of free charges in semiconductors to phenomena occurring in substances characterized by low mobility. The semiconducting properties of amorphous (liquid and solid) bodies are discussed, and it is postulated that, in semiconductors with the mobility $u = 5\ cm^2/V\ sec$ in which the free electron path is shorter than the lattice parameter (or even the interatomic distance), the electron does not move through a series of lattice periods but sporadically jumps from one crystal cell to its neighbour. If it is assumed that the electron moving from one cell to another has to cross an energy barrier of some kind, and that the required energy is supplied by the thermal vibrations of the medium, the frequency of the electron "jumps" should be determined by the Boltzmann factor $\exp(-E/kT)$. Since the mobility is proportional to the number of transitions in unit time, it should follow that $u \approx \exp(-E/kT)$. Such a relationship has, in fact, been observed in several semiconductors (Se, B, NiO, Fe_2O_3, In_2Te_3). In view of these considerations it becomes questionable whether rigid periodicity of the crystal lattice is a necessary condition for the existence of the Brillouin zones and for the movement of free electron charges, the implication being that there are two mechanisms of electrical conduction. M.H.Sloboda

539.2 : 537.311

9953 ELECTRICAL PROPERTIES OF THIN-FILM SEMICONDUCTORS. F.S.Ham and D.C.Mattis.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 143-51 (April, 1960).

The theory of the electrical properties of metal films as given by Fuchs and Sondheimer is extended to nondegenerate semiconductors with ellipsoidal energy surfaces. A change of variables reduces the problem to a simpler one with spherical energy surfaces but with electric and magnetic fields which are tilted with respect to the film. This is solved to first order in the applied fields. The effective mobility and Hall coefficient vary with film

thickness much as for a metal but show an anisotropy with film orientation, even for cubic crystals. Anisotropy is observed for both diffuse and specular surface scattering and for surface channels as well as films, and it provides a means of measuring the effective mass ratio of the carriers.

539.2 : 537.311

9954 MICROWAVE MEASUREMENT OF SEMICONDUCTOR CARRIER LIFETIMES. H.A.Atwater.

J. appl. Phys., Vol. 31, No. 5, 938-9 (May, 1960).

A more complete analysis of the method in which a pulse of minority carriers is injected into a slice of semiconductor placed transversely across a waveguide, is given. The time constant of the microwave power attenuation transient curve can furnish a direct evaluation of surplus carrier lifetime provided certain experimental conditions are satisfied. C.A.Hogarth

539.2 : 537.311

9955 SURFACE TRANSPORT IN SEMICONDUCTORS. R.F.Greene, D.R.Frankl and J.Zemel.

Phys. Rev., Vol. 118, No. 4, 967-75 (May 15, 1960).

A transport theory is given for electrons and holes in space-charge layers at semiconductor surfaces. For diffuse surface scattering, the effective surface may differ significantly from the bulk mobility for any strength of space-charge layer. Agreement with Schrieffer's formulae (Abstr. 2732 of 1955) is found only for strong space-charge layers, and the discrepancy is explained. The results are extended to cover an arbitrary degree of diffuseness of surface scattering and to cover samples of small thickness.

539.2 : 537.311

9956 THE EFFECT OF AN ELECTRIC FIELD ON THE DECAY OF EXCESS CARRIERS IN SEMICONDUCTORS. B.K.Ridley.

Proc. Phys. Soc., Vol. 75, Pt 1, 157-61 (Jan., 1960).

Analysis of steady-state and transient conditions using a rectangular filament as model. Sweep-out effects at high electric fields can affect the form of the decay of photoconduction and approximate expressions are given for the decay rate when the decay is not too far removed from exponential. C.A.Hogarth

539.2 : 537.311

9957 ON THE ELECTRON–LATTICE INTERACTION IN NON-POLAR SEMICONDUCTORS. S.Koshino.

Progr. theor. Phys., Vol. 18, No. 1, 23-32 (July, 1957).

The two-phonon process in non-polar semiconductors is discussed and the acoustical mode-scattering mobility is derived from this type of electron-lattice interaction. The mobility depends on T^{-2}. This result is combined with the usual one-phonon process which depends on $T^{-1.5}$, and it is concluded that this process is predominant at lower temperatures while the two-phonon process is predominant at higher temperatures. It is shown that the transition of mobility from the one-phonon region to the two-phonon region can account for the transition of the temperature dependence of the lattice scattering mobility in germanium and silicon. The small deviations of temperature dependence of the observed mobilities from T^{-3} or $T^{-1.5}$ seem to be explained with the optical mode-scattering.

539.2 : 537.311

9958 KINETIC THEORY OF IMPACT IONIZATION IN SEMICONDUCTORS. L.V.Keldysh.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 713-27 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 509-18 (March, 1960).

The effect of impact ionization processes on the distribution function for electrons and holes in a strong electric field is studied. It is shown that the energy dependence of the impact ionization probability near the threshold is essentially different for crystals with small and high dielectric constants; the solution of the kinetic equation is considered in both these cases. Expressions are obtained for the equilibrium number of carriers in a strong field, the impact-ionization coefficient, the critical field, etc. The dependence of the breakdown field on temperature, on specimen thickness, and on the electron–lattice interaction law is found. The connection of the expressions obtained with the known breakdown criteria of Fröhlich and Hippel is established. It is shown that increasing the electric field causes a decrease in the recombination speed, as a result of which the equilibrium number of carriers starts growing as the field increases long before the appearance of impact ionization.

539.2 : 537.311

9959 CHANGE OF THE SURFACE CONDUCTIVITY OF GERMANIUM DUE TO ADSORPTION. V.I.Fistul' and D.G.Andrianov.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 2, 374-6 (Jan. 11, 1960). In Russian.

The ratio of the surface conductivities after etching in pure acids (impurity less than 10^{-6}%) and after etching in acids with impurities between 0.05 and 1% was determined. A table shows the results for eight impurities in mixture of HNO_3, HF and CH_3COOH in proportions 3:2:1. Cu, K, Cr, Fe, Ca and Ag increase conductivity, Zn and Cd reduce it. Br has the largest reducing effect. R.Berman

539.2 : 537.311

9960 INVESTIGATION OF THE HALL EFFECT AND TRANSVERSE MAGNETORESISTANCE IN GERMANIUM IN FIELDS UP TO 400 kOe. V.R.Karasik.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 3, 521-2 (Jan. 21, 1960). In Russian.

A previously described method was used to produce high magnetic fields [Abstr. 4068B of 1959; Pribory i Tekh. eksper., 1959, No. 1, 142-5 (Jan.-Feb.)]. Specimens were Sb-doped (3 ohm. cm at room temperature) and almost intrinsic p-type germanium. Measurements were made at 77 and 20.4°K. The Hall constant varies by 15% over the whole field range at 77°K for each specimen but is constant at 20.4°K. Curves are also shown for transverse magnetoresistance at both temperatures. The results are stated to be in disagreement with theory. R.Berman

539.2 : 537.311

9961 INTERNAL FIELD EMISSION AT NARROW SILICON AND GERMANIUM p–n JUNCTIONS. A.G.Chynoweth, W.L.Fieldmann, C.A.Lee, R.A.Logan and G.L.Pearson.

Phys. Rev., Vol. 118, No. 2, 425-34 (April 15, 1960).

A detailed study was made of the reverse characteristics of several silicon and germanium alloyed p–n junctions with breakdown voltages in the range of about 0.1 to 0.8 V. In these junctions the reverse current is generated almost entirely by internal field emission (tunnelling). The reverse bias characteristics are insensitive to the dislocation density present so that the tunnelling current occurs mainly in undistorted material. From capacitance studies it is established that these narrow junctions are very close to being ideal step junctions. The room-temperature reverse characteristics are analysed in terms of the usual tunnelling probability expressions and in particular, good agreement, both qualitative and quantitative, is found between experiment and theory. The tunnelling probability $\exp(-\alpha\epsilon^{3/2}/E)$, when compared with experiment, yields values for $\alpha\epsilon^{3/2}$ in agreement with the theoretical ones to within a factor of less than 2 for both silicon and germanium. The critical voltage (the reverse bias voltage necessary to maintain a constant tunnelling current) was measured as a function of temperature from 4.2° to 700°K. In germanium, the critical voltage drops monotonically as the temperature increases whereas in silicon, there is considerable structure in the curve. This is shown to be consistent with the tunnelling being by direct transitions in germanium and by indirect transitions (involving phonon emission and absorption) in silicon. In germanium, the temperature dependence of the critical voltage arises from that of the direct energy gap while in silicon, it is determined, primarily, by the available phonon density. From an analysis of the temperature data for silicon that invokes the transverse acoustic phonons, the estimate of $\alpha\epsilon^{3/2}$ that is obtained is in excellent agreement with that found, independently, from the analysis of the reverse characteristics.

539.2 : 537.311

9962 MEASUREMENT OF LIFETIME IN Ge FROM NOISE. S.Okazaki and H.Oki.

Phys. Rev., Vol. 118, No. 4, 1023-4 (May 15, 1960).

The lifetime of the minority carrier can be obtained from a noise measurement whose method consists of liberating hole-electron pairs by light. A convenient experimental arrangement is suggested and a typical plot of the experimental results are shown. The curves of the results are compared with the calculated curves.

539.2 : 537.311

9963 THE DETERMINATION OF THE CONCENTRATION OF IMPURITIES IN GERMANIUM. R.M.Vinetskii and E.G.Miselyuk.

Fiz. tverdogo Tela, Vol. 2, No. 1, 67-9 (Jan., 1960). In Russian.

The temperature dependence for lattice scattering of carriers (L) is greater than that for impurity scattering (I); the ratio of resistivities at 290° and 100° K thus decreases as I increases. The difference between the logarithm of this ratio for pure L (0.771 and 1.079 for n- and p-type Ge, respectively) and for a given specimen showing L and I enables the total concentration of ionized impurities (N) to be read off standard curves. The method is valid for $N < 5\times10^{16}/cm^3$, and is of particular value for compensated material.

C.H.L.Goodman

539.2 : 537.311

9964 THE ELECTRICAL CONDUCTIVITY OF GERMANIUM IN HIGH ELECTRIC FIELDS AT LOW TEMPERATURES. É.I.Abaulina-Zavaritskaya.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1342-50 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 953-9 (Nov., 1959).

The electrical properties of single-crystal germanium doped with Sb, Bi, and Zn were studied in the temperature range 2-10° K. In high electric fields, the electrical conductivity of germanium displays three regions, in the last of which (the so-called "breakdown" region) a sharp conductivity increase is observed. The phenomenon of breakdown is associated with the development of an avalanche in the conduction band, independent of the conduction mechanism in the germanium at low temperatures. The product of the breakdown field E_b and the mobility μ is a function of I/kT, where I is the ionization energy of the impurity in the germanium. The effect of various factors (temperature, magnetic field) on E_b is mainly due to their influence on the carrier mobility. The dependences of E_b and resistance on magnetic field are found to be similar in character.

539.2 : 537.311

9965 THE DIFFUSION LENGTH OF THE CHARGE CARRIERS IN SILICON PHOTO-ELEMENTS. V.S.Vavilov, L.S.Smirnov and V.M.Patskevich.

Fiz. tverdogo Tela, Vol. 1, No. 9, 1465-7 (Sept., 1959). In Russian.

An attempt was made to determine the diffusion length by a method which would eliminate the effects of traps and surface recombinations on the results of the measurements. The suggested method was tested on photo-elements made of 8.9-8.9 ohm cm Si, characterized by a lifetime of 30 μsec (equivalent to a diffusion length of 300 μ). The experimental results failed to confirm the basic postulates of the suggested method in their entirety, but the obtained data gave the correct values of the diffusion length, the maximum deviation from its mean value being ±50%. M.H.Sloboda

539.2 : 537.311

9966 "BREAKDOWN" OF SILICON ALLOY DIODES IN THE FORWARD DIRECTION. Zh.I.Alferov and É.A.Yaru.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1879-82 (Dec., 1959). In Russian.

Reports a breakdown effect such that the forward voltage increase together with the current up to a point where the voltage drop across the diode falls and the current rises. Specimens were made from n-type silicon of 10-30 ohm cm and 100-200 ohm cm. Junctions were made with aluminium and of area 10^{-3} cm². The base contact was Sn –As alloy. The spread in breakdown voltage was large but for the bulk of the diodes it lay in the range 10-20 V and at a current of 10-20 mA. The voltage across the diode after breakdown was about 1 volt. W.Bardsley

539.2 : 537.311

9967 p LAYERS ON VACUUM HEATED SILICON. F.G.Allen, T.M.Buck and J.T.Law.

J. appl. Phys., Vol. 31, No. 6, 979-85 (June, 1960).

It has been established that when silicon is heated above 1300° K in a borosilicate glass vacuum system, from 10^{11} to 10^{13} acceptors per cm³ are normally added to the silicon surface, even though the glass walls remain at room temperature. The acceptor diffuses into the surface upon heating forming a p-layer several microns deep. There is strong evidence that the acceptor is boron from the borosilicate glass envelope. The transfer to the silicon is believed to occur through volatilization of boron oxides by water vapour.

539.2 : 537.311

9968 LOW-TEMPERATURE IMPURITY CONDUCTION IN n-TYPE SILICON. K.R.Atkins, R.Donovan and R.H.Walmsley.

Phys. Rev., Vol. 118, No. 2, 411-14 (April 15, 1960).

Hall coefficients and electrical resistivities were measured down to liquid helium temperatures for silicon specimens containing about 10^{17} phosphorus impurities per cm³ and about 10^{18} boron impurities per cm³. The density of minority impurities was determined during the preparation of the ingots, rather than deduced from the electrical measurements themselves. The results are extremely sensitive to the density of minority impurities. They are discussed in relationship to the theories of Conwell, Mott and Price.

539.2 : 537.311

9969 GALVANOMAGNETIC EFFECTS IN N-TYPE SILICON. W.E.Krag.

Phys. Rev., Vol. 118, No. 2, 435-50 (April 15, 1960).

The galvanomagnetic effects in n-type silicon were investigated experimentally and theoretically at 77° and 300° K. The samples ranged in resistivity from 0.2 to 27 ohm-cm (at room temperature). Measurements of the field dependence from 0.5 to 22 kG of the Hall coefficient and the magnetoresistance for several orientations are presented, as well as measurements of the angular dependence of the magnetoresistance and planar Hall effects at similar fields. A number of theoretical calculations using a constant relaxation time in the manner of Gold and Roth (1957) are presented which show the effect on the coefficients of a change in the mass anisotropy K_m. The Boltzmann transport equation, and collision times of the form

$$\nu_l = I_l \varepsilon^{-s/2} + L\varepsilon^{1/2} + N,$$
$$\nu_t = I_t \varepsilon^{-s/2} + L\varepsilon^{1/2} + N,$$

where ν_l and ν_t are the longitudinal and transverse collision times, I_l, I_t, L, and N are constants and ε is the energy, have been used to calculate the galvanomagnetic coefficients for different amounts of lattice, ionized impurity and neutral impurity scattering, and for different anisotropies of the ionized impurity scattering. The various components of the collision frequency were taken from available theoretical work. Detailed comparisons of the experimental data and the theoretical calculations are presented which show that the assumption of a constant collision frequency allows one to predict qualitatively all the field dependencies and symmetries which are found experimentally. It is also shown that with an anisotropic, energy dependent collision frequency, the quantitative agreement with experiment is considerably improved, especially with regard to the behaviour of samples of different resistivities.

539.2 : 537.311

9970 CRYSTAL POTENTIAL AND ENERGY BANDS OF SEMICONDUCTORS. III. SELF-CONSISTENT CALCULATIONS FOR SILICON. L.Kleinman and J.C.Phillips.

Phys. Rev., Vol. 118, No. 5, 1153-67 (June 1, 1960).

For Pt II, on cubic boron nitride, see Abstr. 4354 of 1960.

An approximately self-consistent crystal potential is constructed for Si from a superposition of free-atom core and a sampling of crystal valence band charge densities. Valence-core exchange is calculated directly from core wave-functions while valence–valence exchange is included using momentum-independent and momentum-dependent approximations taken from the results for a free-electron gas. The resulting crystal potential is surprisingly similar to one previously obtained by Woodruff from a superposition of free-atom change densities. The calculated valence wave-functions in the core region differ substantially from those of charge densities. of the variational method used by him to calculate wave-functions in that region. As a result the calculated energy gap is changed from Woodruff's value of 4 eV to about 1.5 eV, in substantially better agreement with the experimental value (1.1 eV). The various uncertainties in the calculation are listed; it is concluded that the relative position of levels near the band gap should be correct to within about 1 eV. Effective masses are also calculated and compared with experiment; the agreement is quite good.

539.2 : 537.311 : 536.63

ELECTRICAL PROPERTIES OF Bi_2Te_3. See Abstr. 8858

539.2 : 537.311

9971 SEMICONDUCTING PROPERTIES OF CUBIC BORON PHOSPHIDE. B.Stone and D.Hill.

Phys. Rev. Letters, Vol. 4, No. 6, 282-4 (March 15, 1960).

Crystals were grown from solution and by a vapour phase reaction. Transmission measurements from 0.2 to 16 microns showed that the energy gap is 6 eV. The crystals grown from solution were p-type with about 10^{18} holes/cm³ and a mobility near 100 cm²/V sec at room temperature. Crystals made from the vapour phase were n-type. Point-contact rectifiers were made on both n and p-type BP, and rectification ratios greater than a thousand were observed at 400° C. C.Hilsum

539.2 : 537.311

9972 SOME ELECTRICAL PROPERTIES OF BORO-SILICO-CARBIDES.

V.V.Aleksandrov, V.I.Pruzhinina, A.I.Rekov, T.S.Tarakanova and E.A.Teplov.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1587-91 (Oct., 1959). In Russian.

Dynamic and static volt–ampere characteristics of B_2SiC, $B_4C.2SiC$, and SiC powders, as well as the temperature dependence of the potential drop at constant current, were determined. It was found that non-linear variation of resistivity which is a characteristic property of SiC was less pronounced in boro-silico-carbides. The resistance of the barrier layer in boro-silico-carbides was lower than that observed in SiC, but bulk resistivity of the former materials was higher than that of the latter. M.H.Sloboda

539.2 : 537.311

9973 HIGH TEMPERATURE HALL COEFFICIENT IN GaAs. L.W.Aukerman and R.K.Willardson.

J. appl. Phys., Vol. 31, No. 5, 939-40 (May, 1960).

Infrared absorption of n-type GaAs suggests that there is a conduction band minimum a few tenths of an eV above the lowest conduction band minimum and the separation was determined by Spitzer and Whelan (Abstr. 6948 of 1959) to be 0.25 eV. Analysis of Hall coefficient data leads to a value of 0.38 eV. It is suggested that the energy difference between the minima is temperature dependent. C.A.Hogarth

539.2 : 537.311 : 621.382

9974 ELECTRICAL CHARACTERISTICS OF SOME GALLIUM PHOSPHIDE DEVICES. J.Mandelkorn.

Proc. Inst. Radio Engrs, Vol. 47, No. 11, 2012-13 (Nov., 1959).

Presents preliminary experimental data, mainly in the form of oscilloscope displays of families of static characteristics, for a series of point-contacts placed alone or in pairs on monocrystalline platelets of GaP. A long-range coupling effect between probe pairs was thought possibly to be related to the electroluminescent effect, but some indication of Ge-like transistor action was also found. F.F.Roberts

539.2 : 537.311

9975 PRODUCTION AND PROPERTIES OF THIN LAYERS OF INDIUM ANTIMONIDE. G.Bate and K.N.R.Taylor.

J. appl. Phys., Vol. 31, No. 6, 991-4 (June, 1960).

A new method of producing thin layers of indium antimonide is described. This consists of suddenly squashing a drop of molten indium antimonide between two optical flats and allowing it to cool. Large area, self-supporting specimens of 10 μ thickness have been prepared in this way and their properties examined. Although these layers are polycrystalline, their electrical and optical properties are in good agreement with the single-crystal materials from which they were obtained.

539.2 : 537.311

9976 PROPERTIES OF p-TYPE InSb IN PULSED HIGH ELECTRIC FIELDS. M.C.Steele and M.Glicksman.

Phys. Rev., Vol. 118, No. 2, 474-7 (April 15, 1960).

The results of experiments at 77°K are described. It is shown that electron-hole pair creation occurs at electric fields greater than 700 V/cm^{-1}. When a sufficient number of pairs are created the Hall coefficient changes from positive to negative. The question of whether holes or possible injected electrons initiate the pair creation is examined in detail. An incipient negative resistance effect in transverse magnetic fields and the absence of any self-pinch effects are also discussed.

539.2 : 537.311

9977 EFFECTS OF HYDROSTATIC PRESSURE ON THE PIEZORESISTANCE OF SEMICONDUCTORS: I-InSn, P-Ge, P-InSb, AND N-GaSb. R.W.Keyes and M.Pollak.

Phys. Rev., Vol. 118, No. 4, 1001-7 (May 15, 1960).

A method for measuring the piezoresistance of a sample under high hydrostatic pressure by comparison with the piezoresistance of intrinsic InSb is described. The method is tested by a measurement of the piezoresistance of p-type germanium and p-type InSb up to 13 000 kg/cm^2. The piezoresistance of these materials is found to be independent of pressure, in good agreement with predictions based on other experiments. Measurement of the piezoresistance of n-GaSb as a function of pressure up to 12 000 kg/cm^2 confirms the correctness of the model of the conduction band which has been proposed by Sagar (Abstr. 2894 of 1960). Values for certain parameters of the conduction band of GaSb are deduced.

539.2 : 537.311 : 548.7

9978 A NEW SEMICONDUCTING COMPOUND IN THE SYSTEM In–Sb–Te. N.A.Goryunova, S.I.Radautsan and G.A Klosse.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1858-60 (Dec., 1959). In Russian.

Five alloys in the In–Sb–Te system were prepared and the X-ray diffraction patterns are given. The crystal structure, lattice constants, and microhardness of all phases were measured. A new compound, In_4SbTe_3, was discovered with an NaCl-type structure and a lattice constant 6.128 ± 0.008 A. D.J.Huntley

539.2 : 537.311 : 621.382.3

9979 TRANSISTOR WITH BASE CONTAINING A DISPERSED COLLOIDAL PHASE. B.R.Gossick.

J. appl. Phys., Vol. 31, No. 4, 745 (April, 1960).

The presence of p-type colloidal particles in the base of a p-n-p transistor should increase the gain-bandwidth products of the transistor. The colloidal particles cause a reduction in the conductivity of majority carriers, and an increase in the mobility of minority carriers. It is suggested that a dispersed colloidal phase of tin would have this effect in n-type germanium. C.Hilsum

539.2 : 537.311 : 621.382.333

9980 THE CUT-OFF FREQUENCY OF THE DRIFT TRANSISTOR, ALLOWANCE BEING MADE FOR THE DRIFT FIELD VARIATION AND FOR THE CARRIER MOBILITY IN THE BASE. B.Ya. Moizhes.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1308-11 (Aug., 1959). In Russian.

To obtain a substantial increase of the cut-off frequency compared with the ordinary transistor it is necessary to have a very large change in the kinetic energy of carriers in the base compared with kT [Abstr. 4059B, 4925B of 1954; 939B of 1955; Arch. elekt. Übertragung, Vol. 8, 223, 363, 499 (1954)]; it follows that the pulse width will be always much smaller than the base width. On this assumption the author bases his derivation of a general formula for the collector current, which includes E and μ. Approximate formulae and some graphs are presented for the limiting frequency ωlim when only E = const., and when the impurities have an exponential distribution. F.Lachman

539.2 : 537.311 : 621.314.63

9981 SURFACE PROBLEMS WITH SEMICONDUCTOR RECTIFIERS. H.H.Plagemann.

Nachrichtentechnik, Vol. 9, No. 7, 292-5 (July, 1959). In German.

A discussion of the effects of the ambient atmosphere on the reverse current of germanium diodes. An increase in humidity leads to an increase in reverse current, and the change is larger in a nitrogen atmosphere than in one of oxygen. It is therefore important to control the atmospheric conditions during transistor production. C.Hilsum

539.2 : 537.311 : 621.314.63

9982 INVERSION BEHAVIOUR OF SILICON RECTIFIERS IN MOIST GASES. O.Jüntsch.

Z. Naturforsch., Vol. 15a, No. 2, 141-9 (Feb., 1960). In German.

The leakage current in p–n silicon rectifiers in damp gases, attributed to the movement of ions of chemisorbed water molecules, is discussed. From equations derived and experimental data the probability of transformation from the state of physical adsorption to that of chemisorption is calculated. Adsorbed ammonia molecules increase the transformation probability w from 0.055 to 0.995. G.C.Williams

539.2 : 537.311 : 621.382

9983 RECTIFICATION WITHOUT INJECTION AT METAL-TO-SEMICONDUCTOR CONTACTS. N.J.Harrick.

Phys. Rev., Vol. 118, No. 4, 986-7 (May 15, 1960).

The author has shown (Abstr. 12250 of 1959; 582 of 1960) that extraction in the semiconductor bulk may occur for either direction of current flow through the same metal-to-semiconductor contact when an insulating layer separates the metal and the semiconductor and the field effect determines the surface barrier under the metal. It is shown here that strong rectification, whose direction depends only on the bulk type, may occur for such contacts to extrinsic, but not intrinsic, semiconductors. Thus, rectification, without injection, may occur at the metal-to-semiconductor contact for the two-carrier system.

539.2 : 537.311 : 621.382

9984 EQUIPMENT FOR THE ENCAPSULATION OF SEMICONDUCTOR DEVICES. R.D.Knight.
J. sci. Instrum., Vol. 37, No. 6, 197-9 (June, 1960).

A hydraulically operated ram carries the semiconductor device and its envelope, loosely assembled, into a Pyrex chamber. Here the two are separated while the envelope is outgassed by e.c.h. in vacuum. They are then brought together, in vacuum or in gas, and the residual heat in the envelope melts a ring of tin in the mount collar to make the final seal. During the process the device is warmed sufficiently to drive off any moisture. A novel three-port valve controls the gas and vacuum supplied to the chamber. The equipment has been designed with a view to ultimate automation.

Photoconductivity

539.2 : 537.312

9985 BECQUEREL PHOTOVOLTAIC EFFECT IN BINARY COMPOUNDS. R.Williams.
J. chem. Phys., Vol. 32, No. 5, 1505-14 (May, 1960).

An experimental study has been made of photovoltaic effects which occur at semiconductor–electrolyte interfaces. Single crystal specimens of CdS and several other compounds were used. It was found that in a number of cases the photovoltaic effect results from a chemical reaction of the electrode materials. In such cases the observations may be explained by a simple mechanism which relates the sign of the photo e.m.f. to the conductivity type of the semiconductor and to the chemical reaction which is occurring. The reaction may be predicted using readily available thermodynamic data. A different process occurs when the electrode material is GaAs. It acts as an inert electrode which exchanges electrons with an oxidation-reduction couple in the solution.

539.2 : 537.312

9986 THE SUPERLINEAR RISE OF PHOTOCONDUCTIVITY OF A PHOSPHOR IN THE INITIAL STAGES OF EXCITATION. V.V.Antonov-Romanovskii.
Optika i Spektrosk., Vol. 7, No. 6, 827-9 (Dec., 1959). In Russian.

Discusses the deficiencies of Tolstoi's (1956, 1959), Frerichs' (1949) and Rose's (1955) theories of the superlinear rise of photoconductivity with time and proposes an energy-band theory of this effect. The band scheme consists of two types of electron traps between a filled and an empty band. A.Tybulewicz

539.2 : 537.312

9987 DETERMINATION OF THE LOSSES AND EFFICIENCY OF VARIOUS PROCESSES IN THE PHOTOELECTRIC UTILIZATION OF SOLAR ENERGY. V.K.Subashiev.
Fiz. tverdogo Tela, Vol. 2, No. 2, 198-204 (Feb., 1960). In Russian.

Diagrams show (1) the change in number and nature of particles and (2) the change in energy, as incident light quanta are transformed into useful energy. A table gives the calculated short circuit current density and current sensitivity for Ge, Si and CdTe photoelements working under illumination conditions corresponding to light from the sun outside the atmosphere, assuming the only losses are non-photoactive absorption and absorption in the electrode. This is then a theoretical upper limit. The efficiency of each process is shown for a silicon photoelement (prepared in 1957 and not characteristic of present elements). Data is also calculated for four hypothetical p–n junctions. R.Berman

539.2 : 537.312

9988 LIGHT WAVES IN CRYSTALS IN THE EXCITON ABSORPTION REGION AND THE IMPURITY PHOTOEFFECT. I.M.Dykman and S.I.Pekar.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 510-21 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 361-8 (Feb., 1960).

The amplitudes of waves in the exciton light absorption region in a cubic crystal are calculated for a given incident wave amplitude. In the frequency region, in which the refractive index $\ll 1$, the amplitudes of the normal and longitudinal waves in the crystal are several hundred times larger than the amplitude of the incident wave. The photo-ionization of impurities is therefore much more intense in this frequency range than in neighbouring regions, and this can account for the sharp maximum in the photoeffect which is often observed in this range. Waves can occur with amplitudes which increase linearly with penetration depth into the crystal. J.Franks

539.2 : 537.312 : 536.3

SINGLE-CRYSTAL INFRARED DETECTORS BASED UPON INTRINSIC ABSORPTION. See Abstr. 8840

539.2 : 537.312

9989 CADMIUM SULPHIDE PHOTOCONDUCTIVE LAYERS. R.Lawrance.
Brit. J. appl. Phys., Vol. 10, No. 6, 298-300 (June, 1959).

Details are given of three methods of preparing CdS photocells. Sensitive cells can be made by evaporation of crystalline CdS, conversion of sputtered CdO by heating in the presence of H_2S, or by a similar heating of melted layers of laboratory reagent cadmium salts. The sensitivity, spectral response and time constant of cells made by these three processes are compared. C.Hilsum

539.2 : 537.312

9990 PHOTOEMISSION IN THE PHOTOVOLTAIC EFFECT IN CADMIUM SULFIDE CRYSTALS.
R.Williams and R.H.Bube.
J. appl. Phys., Vol. 31, No. 6, 968-78 (June, 1960).

A study has been made of the photovoltaic effect in Cu–CdS cells and related systems, associated with undiffused metal–semiconductor junctions. The photovoltaic current has been shown to result from the photoemission of electrons from the copper metal into the CdS crystal. Direct evidence is presented for this conclusion, and the conditions required for the photoemission process to occur are demonstrated by several experiments. Important factors contributing to the efficiency of Cu–CdS photovoltaic cells of this type are: (a) the optical properties of copper, (b) the rectifying contact between the metal and CdS, (c) the good conductivity and high optical transparency which can be achieved in CdS crystals, and (d) the favourable relation between the work function of copper and the electron affinity of CdS.

539.2 : 537.312

9991 FREQUENCY FACTOR AND ENERGY DISTRIBUTION OF SHALLOW TRAPS IN CADMIUM SULFIDE.
J.J.Brophy and R.J.Robinson.
Phys. Rev., Vol. 118, No. 4, 959-66 (May 15, 1960).

Current noise and photoconductivity measurements taken under uniform 5200 A illumination on CdS single crystals are used to derive the energy distribution and frequency factor of shallow traps in the range 0.3 to 0.6 eV below the conduction band for samples of different CuCl impurity content. Trap densities varying from 10^{15} to 10^{17} cm^{-3} eV^{-1} and total trap concentrations of 10^{16} cm^{-3} with discrete levels at 0.36, 0.43, and 0.60 eV below the conduction band are observed. In a moderately doped, good photosensitive crystal, the traps also have a continuous distribution in energy and all have the same frequency factor, 10^{11} sec^{-1}, which suggests the traps are structurally similar. The results imply that a photoelectron may experience several thousand retrapping transitions on the average before recombining. It is possible to account semiquantitatively for the 1/f noise spectrum observed in some crystals at high frequencies in terms of the near exponential trap distributions and constant frequency factor derived from low-frequency noise measurements.

539.2 : 537.312

9992 THE INFLUENCE OF GASEOUS ATMOSPHERES ON THE SPECTRAL DISTRIBUTION OF THE PHOTOCONDUCTION OF SINGLE CRYSTALS OF CdS.
H.Berger, K.W.Böer and E.H.Weber.
Z. Phys., Vol. 158, No. 5, 501-10 (1960). In German.

Curves are given for the variation of photocurrent with wavelength in the range 460–250 mμ before and after contact with various gases. Water vapour and O_2 both decrease the photocurrents, particularly at the shorter wavelengths; this suggests the formation of electron traps after adsorption, and that O_2 can diffuse into the crystal. Active hydrogen increases the photocurrent; the effect is short lived, and can serve as a sensitive detector for active hydrogen. G.F.Lothian

539.2 : 537.312

9993 PHOTOCONDUCTIVITY OF THE HALOPHOSPHATES OF CALCIUM. G.Déjardin, J.Janin and L.Cotton.
Cahiers de Phys., Vol. 13, No. 106, 217-24 (June, 1959). In French.

A commercial halophosphate phosphor was tested as unactivated matrix, with Sb, with Mn, and with Sb and Mn; also the corresponding materials of high purity, not containing the traces of Sb and Mn found in all the commercial products. Radiation at 1850 A was required to induce photoconductivity. With layers 0.5 mm thick at

~ 200 V, dark currents of ~ 10^{-13} A were measured for all the samples except the pure ones with Sb or Mn only, which gave higher values. Photocurrents were of the same order as dark currents for the commercial products, lower for the pure materials especially that with Sb only. The results are discussed with regard to the different function of Sb and Mn, and the resonance transfer of excitation energy is confirmed. S.T.Henderson

539.2 : 537.312

9994 SPECTRAL CHARACTERISTICS OF GaAs PHOTOCELLS. D.N.Nasledov and B.V.Tsarenkov.
Fiz. tverdogo Tela, Vol. 1, No. 9, 1467-70 (Sept., 1959). In Russian.

The dependence of the spectral characteristics of GaAs photocells on the temperature of diffusion of Cd and Zn during the formation of a p–n junction, and their dependence on etching, have been investigated. The cut-off of the spectral characteristic in the short wavelength region increases with an increase in the temperature of diffusion, and the maximum is displaced to longer wavelengths. Etching minimizes the cut-off and displaces the maximum towards shorter wavelengths. The observed behaviour is explained by a change in the depth of the illuminated p-region. K.N.R.Taylor

539.2 : 537.312

9995 THRESHOLD SENSITIVITY AND NOISE SPECTRUM OF GERMANIUM JUNCTION PHOTODIODES. L.Ya.Perova.
Radiotekhnika i Elektronika, Vol. 4, No. 2, 330-4 (Feb., 1959). In Russian.

Describes the results of measurements of threshold sensitivity and magnitude and spectral distribution of noise between 0.5 c/s and 20 kc/s. The sensitivity threshold was found to be of the order of 10^{-16} lumen sec^{-1} cm^{-2} for a light flux modulation frequency of 70 c/s. The noise spectrum was found to follow a 1/f distribution up to several hundred cycles/sec but at high frequencies was near the value of dark current shot noise. [English summary: PB 141106 T-13 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. R.C.Glass

539.2 : 537.312

9996 PREPARATION AND PROPERTIES OF PbTe PHOTORESISTORS WITH CONTROLLED STOICHIOMETRIC COMPOSITION. K.Gürs.
Z.Phys., Vol. 158, No. 5, 533-52 (1960). In German.

The photoresistors were measured in closed cells without the admission of air. Stoichiometry was achieved by treatment in Te vapour. For high resistance layers, the dark currents at various field strengths varied faster than exponentially with voltage. The dependence of photosensitivity on mode of film preparation was investigated, as functions of wavelength. C.A.Hogarth

539.2 : 537.312

9997 ENERGY DIAGRAMS OF PRACTICAL SILICON PHOTOELEMENTS. V.K.Subashiev and E.M.Pedyash.
Fiz. tverdogo Tela, Vol. 2, No. 2, 213-20 (Feb., 1960). In Russian.

An account is given of a method of constructing the energy diagrams of practical photoelements and distribution in concentration of carriers in them for equilibrium conditions, on the basis of experimental data obtained from measurements on photoelements and on the basic material. K.N.R.Taylor

539.2 : 537.312

9998 PHOTOELECTRIC PROPERTIES OF ANODICALLY PRODUCED TITANIUM AND NIOBIUM OXIDE LAYERS. J.Rupprecht.
Naturwissenschaften, Vol. 47, No. 6, 127-8 (1960). In German.

The maximum photovoltage exhibited by oxidized layers is independent of light intensity and changes little with oxide layer thickness. In the case of titanium oxide, a titanium doping of the oxide seems likely. G.F.J.Garlick

539.2 : 537.312 : 535.37

EFFECT OF PULVERIZATION ON THE OPTICAL AND ELECTRICAL PROPERTIES OF CERTAIN ZnS PHOSPHORS.
See Abstr. 10084

539.2 : 537.312

9999 SURFACE CONTROLLED BULK CONDUCTIVITY IN ORGANIC CRYSTALS. H.Kallmann and M.Pope.
Nature (London), Vol. 185, 753 (March 12, 1960).

Photoconduction studies on anthracence using sodium chloride and iodide electrolytes as electrodes indicate that excitons are produced by incident photons and diffuse to electrodes where they dissociate releasing holes for current flow. The more polarisable iodide has a greater quenching action for excitons than the chloride. G.F.J.Garlick

539.2 : 537.312

10000 BULK CONDUCTIVITY IN ORGANIC CRYSTALS. H.Kallmann and M.Pope.
Nature (London), Vol. 186, 31-3 (April 2, 1960).

The energy balance is obtained for hole injection into anthracene with electrodes containing I_2 in solution. It is concluded that charge injection can easily occur and is frequently responsible for the large currents observed (see Abstr. 4371 of 1960). J.Franks

539.2 : 537.312 : 621.383

10001 A NEW ELECTROPHOTOGRAPHIC PROCESS EMPLOYING COMBINED ELECTRET LAYERS. B.M.Golovin, I.S.Zheludev, N.T.Kashukeev, I.N.Orlov, V.M.Fridkin, L.Ya.Mogilevskaya and A.S.Antonov.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 5, 1008-11 (Dec. 11, 1959). In Russian.

Describes a device consisting of an adjacent pair of photoconductive and dielectric layers, across which a constant voltage can be applied by means of two electrode layers; the electrode adjacent to the photoconductor is transparent to the incident radiation, and the dark resistance of the photoconductor is arranged to be very much greater than that of the dielectric layer. The incidence of a suitable optical image on the photoconductor causes a latent image to be produced in the form of an internal polarization distribution in the dielectric, and this latent image can be subsequently reconstructed either by electron beam scanning or, if the dielectric is itself chosen to exhibit photoconductivity, by flying spot scanning. The case where CdS and ZnS are used for the photoconductor and electret layers respectively is particularly considered, and experimental results are given. V.V.Zakharov

Thermoelectric Properties

539.2 : 537.32

10002 PRINCIPLES OF THERMOELECTRIC DEVICES. H.J.Goldsmid.
Brit. J. appl. Phys., Vol. 11, No. 6, 209-17 (June, 1960).

In recent years, the use of semiconductor thermojunctions has improved the efficiency of generation by means of the Seebeck effect and has made thermoelectric refrigeration a practical possibility. By using semiconducting compounds of high mean atomic weight, Seebeck coefficients of about 200 $\mu V/^{\circ}C$ have been obtained without the ratio of electrical to thermal conductivity departing too far from the value given by the Wiedemann–Franz law for metals. The most favourable semiconductors have been improved still further by alloying with isomorphous materials. Devices employing the thermoelectric effects are discussed.

539.2 : 537.32

10003 THERMOELECTRICITY AT VERY LOW TEMPERATURES. D.K.C.MacDonald, W.B.Pearson and I.M.Templeton.
Physica, Vol. 24, Supplement, S171 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Direct measurements have been made of the absolute thermoelectric power (S) of all the alkali metals between 2° and 20°K. These show considerable variety of behaviour and the heavier metals, rubidium and caesium, are particularly anomalous. Current theoretical investigations by Bailyn and Ziman suggest that Umklapp-processes and "phonon-drag" effects may play a strong role. The work has been extended to temperatures below 1°K, and some results have been obtained on the noble metals as well as on the alkali metals. The noble metals, in particular, show a very large absolute thermoelectric power for which it seems very difficult to account on present theory.

539.2 : 537.32

10004 THERMOELECTRIC PHENOMENA IN STRONG MAGNETIC FIELDS IN METALS POSSESSING VARIOUS FERMI SURFACES. Yu.A.Bychkov, L.É.Gurevich and G.M.Nedlin.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 534-539 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 377-80 (Feb., 1960).

The asymptotic behaviour is investigated of the thermoelectric

force, Peltier coefficients, and Thomson coefficients for metals with closed Fermi surfaces and open surfaces of the "corrugated cylinder" and "space net" types. The investigation is based on the quasi-classical theory of kinetic phenomena in metals, as developed by Lifshits, Azbel' and Kaganov (Abstr. 360 of 1957) and by Lifshits and Peschanskii (Abstr 2358 of 1959).

539.2 : 537.32

10005 THERMOELECTRIC COEFFICIENTS OF METALS IN STRONG MAGNETIC FIELDS AND THE EFFECT OF DRAG OF ELECTRONS BY PHONONS.
L.É.Gurevich and G.M.Nedlin.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 765-75 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 546-52 (March, 1960).

The behaviour of the thermoelectric tensor in strong magnetic fields, when the electron Larmor frequency is greater than the collision frequency, is considered by the methods proposed by Lifshits et al. (Abstr. 360 of 1957; 2275 of 1958; 2358 of 1959). The drag of the electrons by phonons is taken into account, and it is shown that this effect significantly changes the asymptotic values of the tensor (for large values of the magnetic field) and also its dependence on the direction of the magnetic field relative to the crystal axes (in the case of a complex topology of the Fermi surface).

539.2 : 537.32

10006 INVESTIGATION OF THE THERMOELECTRIC PROPERTIES OF THE COMPOUND $CoSb_3$ WITH ELECTROACTIVE IMPURITIES Sn, Te, and Ni.
B.N.Zobnina and L.D.Dudkin.
Fiz. tverdogo Tela, Vol. 1, No. 12, 1821-7 (Dec., 1959). In Russian.

The electrical conductivity (σ) and thermoelectric power (α) are given for polycrystalline specimens with concentrations of up to 0.5% Sn and Te and 3% Ni; these indicate that the maximum solid solubility is 0.15% Sn and 0.25% Te. The thermoelectric power is positive with Sn and negative with Te and Ni. The temperature dependence of σ and the Hall constant R are given between 150 and 1000°K. At 500°K, with either Te or Ni, R changes sign showing a transition from metallic to intrinisic conductivity. The carrier concentrations, mobilities, chemical potentials (μ) and effective masses are given. The values of μ indicated that some specimens were strongly degenerate. The hole mobility was about ten times larger than the electron mobility and the effective mass about ten times smaller. The carrier and impurity densities are compared and the differences discussed with reference to a theory of narrow impurity bands. D.J.Huntley

539.2 : 537.32

10007 THERMOELECTRIC POWER OF DILUTE COPPER ALLOYS. F.J.Blatt and R.H.Kropschot.
Phys. Rev., Vol. 118, No. 2, 480-9 (April 15, 1960).

The thermoelectric power of dilute binary copper alloys containing 1 at. % Zn, Ge, Cd, In, Sn, and Sb was determined over the temperature range from about 8° to 320°K. The thermoelectric powers were obtained by measuring the thermoelectric e.m.f.'s of thermocouples formed of the alloys and pure copper. The absolute thermoelectric power of pure copper was obtained from measurements on a pure copper versus lead thermocouple. The results are analysed in terms of the Friedel theory. It is found that above 40°K satisfactory agreement with that theory can be obtained only if it is assumed that phonon drag makes a significant contribution to the thermoelectric power in the pure material below room temperature. The magnitude and temperature dependence of this assumed phonon drag contribution are in satisfactory agreement with theoretical estimates. Moreover, the effect of alloying on this phonon drag contribution also agrees with theoretical estimates based on reasonable models. In the temperature range below about 40°K no satisfactory interpretation of these results can be given. The measurements show that near 40°K the absolute thermoelectric power of pure copper reverses sign, becoming negative, and attains an anomalously low minimum of about -1.8 μV/deg near 10°K. If this behaviour is due to the presence of minute amounts of impurities in the pure copper which give rise to a thermoelectric anomaly associated with the appearance of a resistivity minimum, then the results can be interpreted without much difficulty. However, the residual resistivity of the pure copper was so low that the low-temperature thermoelectric anomaly cannot be attributed to the presence of impurities. A research programme on thermoelectric properties of dilute alloys which should shed further light on these questions is outlined.

539.2 : 537.32 : 538.2

10008 THE THERMOELECTRIC PROPERTIES OF THE PHOSPHIDES OF MANGANESE.
V.P.Krasovskii and I.G.Fakidov.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 3, 477-8 (1959). In Russian.

(1) Results of Guillaud (Rev. mod. Phys., Vol. 25, 119, 1953) on the variation of the Curie point, T_C, of MnP with applied magnetic field were not confirmed: T_C = 22° C by all methods of measurement. (2) The thermoelectric power (α) of two specimens, containing various proportions of MnP and Mn_2P, was measured in the temperature range -180 to 100° C. The shape of the $\alpha(T)$ curves for both was found to be the same (minimum at about -50° C). Below -50° C the behaviour of $\alpha(T)$ was anomalous and unexplained. Above -50° C $\alpha(T)$ was typical of a ferromagnetic conductor and agreed with the temperature dependence of resistivity for MnP and Mn_2P. Conduction was always p-type with very few charge carriers. See also Abstr. 1674 (1960). A.F.Brown

Dielectric Properties

539.2 : 537.2

10009 EFFECT OF THE LATTICE ON DIELECTRIC PROPERTIES OF AN ELECTRON GAS. D.S.Falk.
Phys. Rev., Vol. 118, No. 1, 105-9 (April 1, 1960).

A system of N electrons in the presence of a rigid periodic background of positive charge is considered. Following Martin and Schwinger, an inverse dielectric operator, $\mathcal{K}'$, is introduced. An approximate equation which takes into account the long-range nature of the Coulomb field is derived for $\mathcal{K}'$. A representation is used where $\mathcal{K}'$ is a matrix with rows and columns labelled by vectors of the reciprocal lattice. Poles and zeros in the dielectric operator are found to be manifestations of Bragg's law. Assuming these to be the major effect of the lattice, the equation for $\mathcal{K}'$ is solved. The result is examined in the weak-binding limit and seen here, except at the Bragg reflections, to agree with that of Nozieres and Pines. Finally, the ground-state energy of the system is exhibited.

539.2 : 537.2

10010 METHOD FOR DETERMINING THE COMPONENTS OF THE COMPLEX DIELECTRIC PERMEABILITY.
S.Ivanov.
J. Phys. Radium, Vol. 19, Suppl. No. 7, 98A-101A (July, 1958). In French.

A method of phase displacement is presented which provides great accuracy in the separation, measurement and the tracing of the changes of the losses as well as of the dielectric permeability. By this method sufficient accuracy is obtained for this kind of measurement, despite the simultaneous display of the losses and the dielectric permeability of crystal phosphors and monocrystals of CdS when illuminated. Other semiconductors could also be investigated by this method. The method of electrical beats characterized by its high sensitivity proved to be unsuitable for the separation mentioned above. Other authors have used resonance methods but with processes proceeding more slowly, they are less accurate than the method here presented. The apparatus with which this method is used permits easy tuning for measurement only of the change of the losses or for measurement only of the changes of the dielectric permeability. Investigations of the changes of the losses and of the dielectric permeability of different mixed phosphors ZnS–CdS activated with Cu are made, as well as of CdS monocrystals when irradiated with the light from a mercury vapour lamp. The kinetics of the processes in both kinds of semiconductors are different.

539.2 : 537.2

10011 THEORY OF DIELECTRIC CONSTANTS OF LiF.
E.R.Levin and E.L.Offenbacher.
Phys. Rev., Vol. 118, No. 5, 1142-9 (June 1, 1960).

The static and high-frequency dielectric constants and the effective charge of LiF are calculated on the basis of a simplified model in which the polarizability of the positive ions is neglected, and that of the negative ion is attributed entirely to perturbations in the outermost subshell (2p) of electrons. The present calculation differs from the variational treatment of Yamashita mainly in the inclusion of perturbed wave-functions for the 2p electrons which are orthogonal to the core-electron wave-functions. Also, different

methods are employed in evaluating portions of the energy of the crystal in a field and in deducing the effective charge ratio e^*/e from the calculated energy. It is found that the use of trial wave-functions which preserve the orthogonality within individual ions is of prime importance, and leads to results in generally better agreement with observation than the previously used nonorthogonal functions.

539.2 : 537.2

10012 DIELECTRIC STUDIES ON POLYCRYSTALLINE SELENIUM. W.Ludwig.

Z. Naturforsch., Vol. 15a, No. 3, 285-6 (March, 1960). In German.

Measurements on material containing 0.1% Br were made over the frequency range from 500 c/s to 1 Mc/s at temperatures between −40° and +160°C. After allowing for the contribution due to d.c. conduction, peaks in the tan δ versus log (frequency) curves were revealed, whose position depended on temperature in the usual exponential manner. The value of the activation energy, which was the same as for d.c. conductivity, was strongly dependent on the heat-treatment of the samples. K.W.Plessner

539.2 : 537.2

10013 IONIC CONDUCTIVITY OF DIELECTRICS. G.Godefroy.

C.R.Acad.Sci. (Paris), Vol. 249, No. 23, 2540-2 (Dec. 9, 1959). In French.

The formation of ionic space charge in polarized ferroelectric specimens is demonstrated using a vibration capacitor technique (Abstr. 1188 of 1956). J.H.Mason

539.2 : 537.2

10014 THE THEORY OF FERROELECTRICS AND ANTI-FERROELECTRICS. V.I.Klyachkin.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1874-7 (Dec., 1959). In Russian.

Conditions for occurrence of phase transitions in ferroelectric and antiferroelectric crystals, earlier studied by Boltzmann statistics, are now subjected to a superior treatment devised by Bogolyubov. Equations for the transition temperatures are deduced. A.E.I. Research Laboratory

539.2 : 537.2

10015 WALL VELOCITY IN FERROELECTRICS. J.C.Burfoot.

Proc. Phys. Soc., Vol. 75, Pt 2, 314-16 (Feb., 1960).

Polarization reversal in ferroelectric single crystals is considered, and some of the experimental problems associated with domain observation and fast switching measurements on metal-electroded specimens enumerated. The difficulty of postulating a unique mechanism to explain the form of the switching transient is illustrated by considering two widely different models which provide similar solutions. L.E.Cross

539.2 : 537.2

10016 CONTRIBUTION TO THE THEORY OF FERROELECTRIC POLARIZATION CURVES. N.S.Akulov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1085-7 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 772-3 (Oct., 1959).

The principles of a polarization theory for single- and multi-domain ferroelectric crystals possessing one or two Curie points are developed for weak, strong, and medium fields at various temperatures. In contrast to the magnetization-curve theory previously developed, it is assumed that rotation can be neglected in the first approximation. The various refinements can be introduced in a way similar to that employed in the magnetization-curve theory.

539.2 : 537.2

10017 MEASUREMENT OF THE COMPLEX PERMITTIVITY OF ROCHELLE SALT AT A FREQUENCY OF 10 Gc/s AS A FUNCTION OF TEMPERATURE AND ELECTRIC BIAS-FIELD. W.Jäckle.

Z. angew. Phys., Vol. 12, No. 4, 148-55 (April, 1960). In German.

The method of measurement is described in detail. The results, covering the temperature range from 10° to 40°C, show the real part of the permittivity to pass through a minimum, the imaginary part through a maximum, at the upper Curie point of 24°C. Application of a d.c. bias field reduces the extent of these extrema. Both d.c. and a.c. fields were directed along the ferroelectric crystal axis. The results are interpreted in terms of a relaxation mechanism, both the spread of relaxation times and their absolute values being temperature dependent. The possibility of modulating the amplitude of microwaves by means of thin Rochelle salt plates is investigated experimentally. K.W.Plessner

539.2 : 537.2

10018 NON-LINEARITY OF SOME FERROELECTRICS AT HIGH FREQUENCIES. A.A.Obukhov.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1730-2 (Nov., 1959). In Russian.

It is shown that the rise of permittivity of $Ba(Ti,Sn)O_3$ solid solutions with an increase of the electric field intensity at high frequencies (~10 Mc/s) is caused by a rise of temperature due to h.f. heating. A.Tybulewicz

539.2 : 537.2

10019 THE DEPOLARIZATION CHARGE OF BARIUM TITANATE AND ITS CONNECTION WITH THE PIEZOELECTRIC EFFECT. F.J.Kolomoitsev and I.A Izhak.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1791-3 (Dec., 1959). In Russian.

Briefly describes an experiment in which disk-shaped specimens of $BaTiO_3$ were set up for piezo-electric measurements. The specimens could also be heated through the Curie point and the depolarization charge measured. The results show that the depolarization charge is proportional to the piezoelectric modulus and the constant was determined experimentally. The result is in excellent agreement with theoretical calculations. A E.I. Research Laboratory

539.2 : 537.2

10020 SPACE CHARGE FIELDS IN $BaTiO_3$. S.Triebwasser.

Phys. Rev., Vol. 118, No. 1, 100-5 (April 1, 1960).

Observations were made in the presence of d.c. electric field bias of: (1) hysteresis loops; (2) double loops above the Curie point; (3) Kerr electro-optic effect above the Curie point and (4) capacitance above the Curie point in $BaTiO_3$. The purpose of these experiments was to determine field distributions in the crystal under an externally applied difference of potential and to examine the extent to which space-charge surface layers cancel the bulk field. The first three types of observations were qualitative in nature. The biased hysteresis loops show normal behaviour with no evidence of field cancellation. Double loop measurements show some evidence of field cancellation, while Kerr electro-optic measurements show strongly nonuniform fields indicating anomalous space-charge fields. The measurements of capacitance above the Curie point indicate that surface layers build up in the presence of a d.c. field, and these surface layers have a capacitance that varies with applied voltage. The results can be understood qualitatively if simple Schottky exhaustion barriers are assumed at the two metal electrode-crystal contacts. Observed asymmetries with respect to the applied fields are discussed.

539.2 : 537.2

10021 ON THE THEORY OF FORMATION OF LATENT ELECTROPHOTOGRAPHIC IMAGES ON PHOTOELECTRETS. V.M.Fridkin.

J. Opt. Soc. Amer., Vol. 50, No. 6, 545-50 (June, 1960).

The process of formation of persistent internal photopolarization in crystals is considered on the basis of the band theory. The results obtained may be used in analysing the process of formation of latent electrophotographic images.

539.2 : 537.2

10022 PERMANENT POLARIZATION OF EBONITE. F.I.Polovikov.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1720-6 (Nov., 1959). In Russian.

The charge in ebonite polarized at a given initial temperature depends on the polarizing field intensity but is independent of the duration of polarization. At a given polarizing field intensity the magnitude and sign of the polarization charge are governed by thermal conditions during polarization. At initial polarization temperatures above 70°C heterocharge predominates in ebonite, while at higher temperatures homocharge is mainly induced. High-frequency heating of ebonite shortens the duration of polarization and produced larger charges. A.Tybulewicz

539.2 : 537.2 : 535.37

10023 THE PHOTOELECTRET STATE AND THE LUMINESCENT AFTERGLOW IN ZnS. V.M.Fridkin.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 4, 773-6 (Dec. 1, 1959). In Russian.

Polycrystalline ZnS was activated with Cu and Cl, and polystyrene

was used as binder. The light sum stored in the specimen when excited with light in the absence of a field, and the photoelectret charge arising in the same specimen in identical conditions, but with a field, were measured simultaneously. The latter was measured by the method of Nadzhakov and Kashukeev (1951, 1952); the light sum was measured with a photomultiplier and an oscillograph. It was found that the photo-polarization/logarithm-of-exposure curve (for $E = 400 \times 10^{-6}$ W/cm^2) shows saturation at $Et = 10^{-3}$ W sec/cm^2, whereas, for the same E, the light-sum/logarithm-of-exposure curve shows saturation at 10^{-4} W sec/cm^2. Moreover, while the processes of formation of the photoelectret state in ZnS are associated with the fulfilment of the law of interchangeability, deviations from this law are observed for the light-sum. The afterglow in ZnS lasts only a few seconds, whereas the photoelectret charge in ZnS keeps on decreasing for a few tens of hours. An attempt is made to explain the mechanisms of the two phenomena. F.Lachman

539.2 : 537.2

10024 PIEZOELECTRICITY. CALCULATION OF THE SPEEDS OF PROPAGATION. H.Paillioux.

J. Phys. Radium, Vol. 19, No. 5, 523-6 (May, 1960). In French.

A mathematical study of the space and time variations of elastic strains, electric and magnetic fields, and polarization, in a general type of medium, piezoelectric but homogeneous, introducing Maxwell's relations, which give a coupling. Plane waves, whose superposition gives the most general state of vibration, are studied. The six velocities are calculated; they depend only on the direction of propagation, and not on the conditions at the limits. Its appears that the piezoelectric coupling has a second-order effect on the velocities, and that, when piezoelectric coefficients are small, mechanical and electrical oscillations may be studied separately.

OPTICAL PROPERTIES OF SOLIDS

539.2 : 535

10025 THE PROBLEM OF THE OPTICAL CONSTANTS OF CONDUCTORS. V.P.Silin.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1443-50 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 1025-30 (Nov., 1959).

The problem is considered of determining the complete set of optical constants of a conductor. It is shown that for an isotropic conductor this set consists not only of the index of refraction and the absorption coefficient, but also of two real quantities corresponding to a complex boundary impedance. The real part of the boundary impedance determines the surface losses in the conductor, while the imaginary part of the dielectric constant determines the volume losses. Dispersion relations are formulated which connect the real and the imaginary parts of the complex surface conductivity. Fluctuations in the electromagnetic field in the conductor are considered and the correlation functions for the field components of a metal filling a half-space obtained.

539.2 : 535

10026 VARIATION OF THE OPTICAL CONSTANT OF BISMUTH IN THE FORM OF A THIN FILM, AS A FUNCTION OF THICKNESS, BETWEEN 2.5 and 10 μ. R.Burtin.

C.R. Acad. Sci. (Paris), Vol. 250, No. 11, 1998-2000 (March 14, 1960). In French.

Briefly discusses the preparation by vacuum evaporation of thin films of bismuth. These have been studied by X-ray diffraction and by electron microscopy; the films were found to be strongly oriented and optically smooth. The thicknesses were measured by interferometry and the optical constants k and n determined. Comparisons are made with the results obtained by other authors.

A.E.I. Research Laboratory

539.2 : 535

10027 OPTICAL PROPERTIES OF EVAPORATED BISMUTH IN THE 3-15 μ SPECTRAL REGION.

M.N.Markov and I.S.Lindstrem.

Optika i Spektrosk., Vol. 7, No. 3, 349-54 (Sept., 1959). In Russian.

The optical constants (refractive index, absorption factor, reflection and transmission coefficients) of vacuum-deposited bismuth layers 0.1-1.0 μ thick were determined from the transmission and reflection spectra of the layers. In this range of thickness the density of the layers is practically the same as the density of massive samples and both the resistivity and the temperature coefficient of resistance are practically independent of the layer thickness.

A.Tybulewicz

539.2 : 535

10028 SOME OPTICAL PROPERTIES OF CADMIUM TELLURIDE. P.W.Davis and T.S.Shilliday.

Phys. Rev., Vol. 118, No. 4, 1020-2 (May 15, 1960).

Some optical properties of CdTe samples having a carrier concentration of the order of 10^{15} cm^{-3} were measured. The index of refraction in the infrared was determined to be 2.61. Values of the absorption coefficient α as a function of frequency were obtained at various temperatures. By plotting $\alpha^{1/2}$ and α^3 against frequency, it was found that at room temperature the minimum energy for direct transitions is 1.50 eV; that for indirect transitions is 1.44 eV. The temperature dependencies between 77° and 373°K are given by $(1.66\text{-}5.6 \times 10^{-4}T)$ eV for direct transitions and $(1.56\text{-}4.1 \times 10^{-4}T)$ eV for indirect transitions.

539.2 : 535

10029 CONTRIBUTION TO THE STUDY OF THE OPTICAL PROPERTIES OF CUPROUS HALIDES AT LOW TEMPERATURES. R.Reiss.

Cahiers de Phys., Vol. 13, 129-72 (April, 1959). In French.

Work carried out on CuCl, CuBr, and CuI over the visible spectrum at 4°, 20° and 77°K. At each temperature there were two distinct types of absorption; one with a coefficient of order 10^4 cm^{-1}, the other with a coefficient of order 3×10^5 cm^{-1}. In the region of strongest absorption there was a maximum of reflecting power, followed by a fall to zero for slightly shorter wavelengths. The results were in agreement with Drude's theory of anomalous dispersion, originally intended for gases; the Lorenz–Lorentz theory for the solid state does not agree so well with these results.

N.Corcoran

539.2 : 535 : 532.7

OPTICAL PROPERTIES OF WATER AND ICE IN THE INFRARED AND RADIOWAVE REGIONS OF THE SPECTRUM.

See Abstr. 8665

539.2 : 535

10030 STUDY OF PHYSICS AND CHEMISTRY OF SURFACES FROM FRUSTRATED TOTAL INTERNAL REFLECTIONS. N.J.Harrick.

Phys. Rev. Letters, Vol. 4, No. 5, 224-6 (March 1, 1960).

Describes preliminary experiments to demonstrate the feasibility of studying the surface properties of optically transparent materials by the analysis of the spectrum of totally internally reflected radiation. Wavelengths in the near infrared were used for germanium specimens. C.A.Hogarth

539.2 : 535

10031 THE REFLECTION COEFFICIENTS OF ANTI-REFLECTION COATED SURFACES OF SILICON PHOTOCELLS. V.Malovetskaya, V.S.Vavilov and G.N.Galkin.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1201-4 (Aug., 1959). In Russian.

The reflection coefficient of silicon surfaces may be lowered by a factor of 3-4 in the region of the maximum sensitivity of a solar battery (~1 μ) by producing a durable layer of SiO_2 on the surface by oxidation. Photocells coated in this way have a short-circuit current 20-25% higher than photocells with clear (etched) surfaces.

A.Tybulewicz

539.2 : 535

10032 INFLUENCE OF FREQUENCY AND STRUCTURE ON THE COMPLEX REFRACTIVE INDEX OF METALS AND OF THIN METALLIC FILMS. M.Gourceaux.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2176-8 (March 21, 1960). In French.

Recent experimental measurements give support to a theoretical formula proposed by the author (see also Abstr. 8900-2 of 1959).

P.M.Davidson

539.2 : 535

10033 THEORY OF THE FARADAY EFFECT IN THE REGION OF EXCITON ABSORPTION OF LIGHT BY MOLECULAR CRYSTALS. A.F.Lubchenko.

Optika i Spektrosk., Vol. 7, No. 3, 332-40 (Sept., 1959). In Russian.

Presents a theory of the Faraday effect in molecular crystals, in which excitons interact weakly with the lattice vibrations and

which can have any value of the absorption factor. The gyration vector which determines rotation of the plane of polarization in an external magnetic field, is calculated. Formulae are obtained which give the dispersion of the Verdet coefficient for crystals of higher and medium syngonies and the values of the refractive index near the exciton absorption bands. A.Tybulewicz

539.2 : 535

10034 THEORY OF THE LINEAR KERR EFFECT IN THE REGION OF EXCITON ABSORPTION OF LIGHT BY MOLECULAR CRYSTALS. A.F.Lubchenko.
Optika i Spektrosk., Vol. 7, No. 3, 341-8 (Sept., 1959). In Russian.

Develops a theory of the linear Kerr effect for molecular crystals in which excitons interact weakly with the lattice vibrations and which can have any value of the absorption factor. Equations are obtained which give the propagation of light, in the exciton absorption region, in the presence of a constant uniform external electric field. A third-rank tensor is calculated which determines the optical anisotropy and the magnitude of birefringence is found for crystals of cubic and medium syngonies on propagation of light along the direction of the external applied electric field, which is parallel to the axis of the highest order. A.Tybulewicz

539.2 : 535.33 : 537.533

OPTICAL PROPERTIES OF OXIDE-COATED METAL SURFACES. See Abstr. 9075

539.2 : 535.33

10035 STUDY OF SUBSTANCES TRANSPARENT IN THE FAR-INFRARED (50-2500 μ). E.Décamps and A.Hadni.
C.R. Acad. Sci. (Paris), Vol. 250, No. 10, 1827-9 (March 7, 1960). In French.

With a spectrometer utilizing three echelette gratings, a mercury arc source, and a pneumatic detector, spectra of atmospheric water vapour, quartz, silica, polystyrene, germanium and silicon have been obtained. In particular the results show that polystyrene is almost completely transparent beyond 200 μ. D.L.Greenaway

539.2 : 535.33

10036 INTERACTION OF MAGNETIC CRYSTALS WITH RADIATION IN THE RANGE 10^4-10^5 cm^{-1}. A.M.Clogston.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 198S-205S (May, 1960).

The optical absorption spectrum of magnetic crystals containing ferric iron in the range 10^4 to 10^5 cm^{-1} consists of a series of sharp peaks superimposed on a strong absorption band. The absorption band is associated with a large Faraday rotation of the transmitted light. The sharp peaks are identified as transitions within the configuration ($3d^5$). The broad band can arise either from an internal transition to ($3d^4 4p$) or to a charge transfer process. Both mechanisms are able to account for the observed intensity and rotation within a factor of two. Because of the Faraday rotation, the charge transfer must be associated with d levels of symmetry Γ_3. The rotation has the opposite sign for the two cases and could be used to distinguish between them.

539.2 : 535.33

10037 DETERMINATION OF THE ABSORPTION SPECTRA OF CRYSTAL PHOSPHORS FROM THE DIFFUSE-REFLECTION SPECTRA. I.P.Shapiro.
Optika i Spektrosk., Vol. 7, No. 6, 798-802 (Dec., 1959). In Russian.

Reports experimental work confirming the correctness of the theoretical expressions linking the absorption coefficients with the diffuse-reflection coefficients of powders, developed by Stepanov and Antonov-Romanovskii (1954, 1957). These expressions are used to derive the absorption spectra and coefficients from the diffuse-reflection spectra of powders of Se, CdI_2, PbI_2, CdI_2.PbI_2 and six sulphide phosphors (FK-106, FKP-03, L-15, ZJ-9, K-49 and FK-102) in the visible and near ultraviolet regions. A.Tybulewicz

539.2 : 535.33

10038 MELTING AND CRYSTAL STRUCTURE: EFFECTS OF THERMAL TRANSFORMATIONS OF IONIC CRYSTALS ON THEIR ULTRA-VIOLET ABSORPTION.
E.Rhodes and A.R.Ubbelohde.
Proc. Roy. Soc. A, Vol. 251, 156-71 (May 26, 1959).

Using a new design of absorption cell, spectrostopic studies in the range 4000 to 2000 A were made on films of salts about 100 μ thick, in order to investigate changes of ionic environment that accompany phase transformations in the crystals, and melting. Behaviour which is theoretically simplest to interpret is shown by lithium iodide. This salt shows changes similar to those previously reported for other alkali halides, though the techniques now developed give much more detailed information. In brief, the wavelength of the absorption maximum shifts to longer wavelengths as the positional disorder increases with rise in temperature of the solid and on melting. Accompanying this shift, the intensity of the absorption maximum decreases and band edges (defined in various ways) shift to longer wavelengths. A group of "low melting" salts previously investigated in other ways shows behaviour in marked contrast with that of the alkali halides. For example, on melting, the absorption maximum may shift either to shorter or longer wavelengths, but in any case the shift is much smaller. Maxima of absorption intensity actually increase, or show only slight decreases on melting. These and other differences between the alkali halides and low melting salts such as KCNS, $AgNO_3$, $LiNO_3$, $NaNO_3$, KNO_3, are attributed to the formation of ionic complexes (including ion pairs) when these salts are melted. This can lead to closer approach between anion and cation, than in the crystal at low temperatures, and thus accounts for the contrast in optical behaviour. Whereas the halides undergo mainly positional disorder on melting, for salts such as the nitrates complex formation on fusion is an important additional mechanism of melting. For KCNS the exceptionally large premelting previously reported for the crystals on the basis of volume and conductance measurements is also observed in ultraviolet absorption measurements.

539.2 : 535.33

10039 THE TEMPERATURE DEPENDENCE OF THE ABSORPTION EDGE IN CdS SINGLE CRYSTALS. H.Radelt.
Z. Naturforsch., Vol. 15a, No. 3, 260-70 (March, 1960). In German.

Continuation of previous experimental work in which the temperature range is extended downwards to 20°K. At the low temperature end, the rate of change of optical energy gap with temperature ($d\Delta E/dT$ in eV/deg K) is reduced to -2.0×10^{-4} from the value of -5.8×10^{-4}, characteristic of the temperature range 120-650°K. C.A.Hogarth

539.2 : 535.33

10040 INFRARED ABSORPTION IN CALCIUM FLUORIDE. K.A.Wickersheim and B.M.Hanking.
Physica, Vol. 25, No. 7, 569-70 (July, 1959).

The four absorption bands which appear when CaF_2 is heated in moist air have previously been ascribed to a hydroxyl ion which substitutes for the fluorine in the lattice. Experimental evidence is presented which indicates that two of the bands are caused by a $CaCO_3$ surface layer. The $Ca(OH)_2$ which forms on the surface during heating is converted to $CaCO_3$ by the CO_2 in the air. C.Hilsum

539.2 : 535.33 : 532.7

10041 THE ABSORPTION BANDS OF Cr^{3+} IONS IN SOLUTIONS, CRYSTALS AND GLASSES. T.Bates and R.W.Douglas.
J. Soc. Glass Technol., Vol. 43, 289T-307T (Aug., 1959).

The absorption spectrum of a transition metal ion is greatly influenced by the strength and symmetry of the electric field due to the surrounding atoms, ions, or molecules, known as ligands. Ligand-field theory shows how the positions and intensities of the absorption bands vary with this field, and for fields of octahedral and tetrahedral symmetry the energy levels may be expressed in an Orgel diagram in which the energy levels are plotted against a parameter which measures the field strength. Application of this theory to Cr^{3+} ions in solutions, crystals, and glasses leads to the conclusion that in glass the ion is surrounded by six oxygens in octahedral symmetry. The absorption bands predicted from this theory are in good agreement with those observed.

539.2 : 535.33

10042 INFRARED LATTICE ABSORPTION OF GaP. D.A.Kleinman and W.G.Spitzer.
Phys. Rev., Vol. 118, No. 1, 110-17 (April 1, 1960).

Transmission and reflectivity measurements on GaP in the wavelength region 1 to 40μ have been analysed to obtain information on the lattice vibrations. The fundamental reflection band has been fitted by dispersion theory and the strength, width, and resonance wavelength (27.3μ) determined. The dielectric constant is found to be 8.5 ± 0.2 in the range $1 < \lambda < 12\mu$ and 10.2 for $\lambda > 40\mu$. The background absorption in n-type samples due to free carriers was reduced by copper diffusion to make possible accurate transmission measurements of the lattice combination bands. An assignment scheme using five frequencies is proposed to explain the combination

bands. The temperature dependence of the bands is consistent with theory for two-phonon processes. One band is observed which appears to be due to molecular vibrations of an impurity not yet identified. From the integrated absorption it is concluded that the principal mechanism for the combination bands is the anharmonic potential energy. See also following abstract.

539.2 : 535.33

10043 ANHARMONIC FORCES IN THE GaP CRYSTAL. D.A Kleinman.

Phys. Rev., Vol. 118, No. 1, 118-27 (April 1, 1960).

The infrared properties and the thermal expansion of gallium phosphide are treated on the basis of a simple model of the anharmonic forces. In this model the anharmonic forces are nearest neighbour central forces characterized by a single parameter. The value of this parameter for GaP is obtained from the integrated absorption recently measured (see preceding abstract) for certain infrared combination bands. It is shown that the observed width of the fundamental resonance (reststrahl) and the observed shift with temperature of the combination bands are consistent with the absorption. This is presented as evidence that the anharmonic mechanism is predominantly responsible for the infrared absorption in the combination bands. It is also shown that the observed thermal expansion is consistent with the same anharmonic model.

539.2 : 535.33

10044 INFRA-RED AND RAMAN SPECTRA OF SINGLE CRYSTALS OF ICE. N.Ockman and G.B.B.M.Sutherland.

Proc. Roy. Soc. A, Vol. 247, 434-40 (Oct. 21, 1958).

Of the 7 possible arrangements of the H atoms that have been suggested for ice crystal, only one is excluded by the absence of any dichroism in the infrared absorption spectrum.

G.F.Lothian

539.2 : 535.33

10045 ABSORPTION AND REFLECTIVITY MEASUREMENTS ON SOME RARE EARTH IRON GARNETS AND α-Fe_2O_3. P.C.Bailey.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 39S-40S (May, 1960).

Measurements of the absorption coefficient of (111) crystal sections of α-Fe_2O_3 were made in the visible and near infrared. Absorption peaks were observed centred at energies of about 12 000 and 16 000 cm^{-1}. Reflectivity measurements on the α-Fe_2O_3 crystals were carried out in the 30 000 to 400 cm^{-1} range. Broad reflectivity peaks are found in the near ultraviolet at 24 500 and 26 000 cm^{-1}, respectively. Very strong reflection peaks resulting from the lattice vibrations are present at energies smaller than 700 cm^{-1}. Several quite sharp peaks are found in the absorption spectra of the rare earth iron garnets of Dy, Ho, Er and Yb in the 10 000 - 13 000 cm^{-1} energy range. The circular dichroism of ytterbium iron garnet is displayed by means of absorption curves for the two senses of circularly polarized light.

539.2 : 535.33

10046 MAGNETO-OPTICAL RESONANCE IN NICKEL AT INFRARED FREQUENCIES. G.S.Krinchik and R.D.Nuralieva.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1022-4 (April, 1960). In Russian. English translation in: Soviet Physics–JETP((New York), Vol. 36(9), No. 4, 724-6 (Oct., 1959).

Infrared resonance absorption in nickel was detected by a magneto-optical method. The resonance wavelength of 4 ± 0.5 μ corresponds to the reorientation energy of the electron spin magnetic moment in the exchange field of a ferromagnet.

539.2 : 535.33

10047 FURTHER ANALYSIS OF THE SPECTRUM OF TRIVALENT SAMARIUM IN SINGLE CRYSTALS OF DIFFERENT SYMMETRY. A.Friederich, K.H.Hellwege and H.Lämmermann.

Z.Phys., Vol. 158, No. 3, 251-60 (1960). In German.

Continuation of an earlier paper (Abstr. 7816 of 1958). Term diagrams are given for groups of lines at 21 580 and 22 150 cm^{-1} for samarium ethylsulphate. From the crystal field splitting of the ground terms of this salt and the nitrate and chloride, curves for the magnetic specific heat of the salts at T = 10-300°K are calculated.

G.F.Lothian

539.2 : 535.33

10048 INVESTIGATION OF THE FUNDAMENTAL ABSORPTION SPECTRUM OF ZINC SULPHIDE. N.A.Vlasenko.

Optika i Spektrosk., Vol. 7, No. 4, 511-17 (Oct., 1959). In Russian.

The fundamental absorption spectrum (in the spectral region 220-600 mμ) of zinc sulphide films produced by vacuum deposition at 5×10^{-5} mm Hg was investigated. The spectrum had a maximum at 325 mμ and a region of strong absorption at long wavelengths, extending to 550 mμ; the latter was absent in the spectrum of ZnS crystals and it disappeared in the case of films when the latter were heat-treated in sulphur vapours or in vacuum. The 325 mμ band represents formation of the first excited state of the lattice by transition of electrons from negative ions to the nearest positive ions. The long-wavelength absorption is due to lattice defects such as dislocations or grain boundaries, or it may be related to localization of the excited state of the lattice at the defects. The temperature dependence of the form of the absorption spectrum of ZnS was obtained between 110 and 500°K.

A.Tybulewicz

539.2 : 535.37

10049 THERMODYNAMIC LIMITATION ON THE CONVERSION OF HEAT INTO LIGHT. M.A.Weinstein.

J. Opt. Soc. Amer., Vol. 50, No. 6, 597-602 (June, 1960).

The problem of converting ambient heat into luminescence radiation is analysed in terms of the thermodynamics of the electromagnetic field. The process is described in terms of the technical efficiency of a light source η, defined as the ratio of the power leaving the source in the form of luminescence radiation to the power supplied to the source in the form of work. For a source at the ambient temperature T, it is shown that the limitation imposed by thermodynamics is, in the steady state, $\eta \leq 1 + T/(T_f - T)$, where T_f is the ratio of the net rate at which the field carries energy away from the source to the net rate at which the field carries entropy away from the source as a result of the luminescence emission. Thus, $T/(T_f - T)$ is the maximum possible contribution of ambient heat to the technical efficiency of a light source. An explicit expression for T_f in terms of the ambient temperature and the spectral distribution of the luminescence emission is obtained. It is shown that $T_f \geq T$, and that T_f is a monotonic increasing function of the ratio of the integrated intensity of the luminescence emission to the bandwidth of the emission spectrum. For moderate integrated intensities and finite (but narrow) bandwidths, it is shown that T_f is approximately equal to the brightness temperature of the light source, and it is concluded that thermodynamics forbids technical efficiencies greater than about 160% for room-temperature light sources of practical brightness. As an example, T_f is calculated for the (green) emission band of a typical ZnS phosphor.

539.2 : 535.37

10050 CLASSIFICATION OF SECONDARY EMISSION. B.I.Stepanov and P.A.Apanasevich.

Optika i Spektrosk., Vol. 7, No. 4, 437-45 (Oct., 1959). In Russian.

Quantum-electrodynamical analysis of transformation of light by matter yields a consistent classification of secondary emission, dividing the latter into scattering and photoluminescence depending on the absence or presence of intermediate processes between the acts of annihilation and generation of photons. The limits of applicability of Vavilov's classification, based on duration and quenching of secondary emission, are discussed.

A.Tybulewicz

539.2 : 535.37

10051 THE INITIAL STAGES OF LUMINESCENCE RISE IN PHOSPHORS WITH LEVELS OF SEVERAL TYPES. V.V.Antonov-Romanovskii.

Optika i Spektrosk., Vol. 7, No. 4, 524-9 (Oct., 1959). In Russian.

Kinetics of the initial stages of luminescence rise is considered in the quasi-linear case when recombination is negligibly small and all free charges are produced by thermal motion. The case of traps of one type is dealt with quantitatively. This is followed by a qualitative discussion of the case when traps of several types are present.

A.Tybulewicz

539.2 : 535.37

10052 CANDOLUMINESCENCE AND LUMINESCENCE DUE TO RECOMBINATION ON THE PHOSPHOR SURFACE IN AN ACTIVE-GAS ATMOSPHERE. A.N.Gorban' and V.A.Sokolov.

Optika i Spektrosk., Vol. 7, No. 4, 569 (Oct., 1959). In Russian.

An experiment is described which confirms that candoluminescence (luminescence in flames) is mainly due to absorption of energy

liberated by recombination of atoms and radicals, present in flames, on the phosphor surface: ZnS:CdS:Cu luminesced under the action of coal-gas in which radicals and atoms were produced by an electric discharge; the luminescence spectrum was identical with that obtained in a Bunsen-burner flame. A.Tybulewicz

539.2 : 535.37

10053 THE SEMICONDUCTING MECHANISM OF SURFACE-RECOMBINATION LUMINESCENCE.

A.N.Gorban' and V.A.Sokolov.

Optika i Spektrosk., Vol. 7, No. 6, 815-17 (Dec., 1959). In Russian.

In earlier work (see Abstr. 5577 of 1959) it was proved experimentally that luminescence in flames (candoluminescence) is due to recombination on the phosphor surface of atoms and radicals, present in the flame, into molecules. It is shown that recombination which produces candoluminescence is satisfactorily explained by the energy-band theory of semiconductors, applied to the phosphor surface. A.Tybulewicz

539.2 : 535.37

10054 POLARIZATION OF THE FLUORESCENCE OF COMPLEX MOLECULES, WHOSE SPECTRA DO NOT OBEY THE MIRROR-SYMMETRY RULE.

A.N.Sevchenko, G.P.Gurinovich and A.M.Sarzhevskii.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1191-4 (Aug. 21, 1959). In Russian.

A previous paper [Gurinovich and Sevchenko, Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, 1407 (1958); Sevchenko, Gurinovich and Sarzhevskii, Abstr. 8018 of 1960] dealt with the molecules of the first kind (complex molecules for which the mirror symmetry of spectra is obtained with respect to frequencies); in the present paper the molecules of the second kind (mirror symmetry with respect to wavelengths) are investigated in order to determine the frequency of a purely electronic transition. Dependence of the degree of polarization of the fluorescence of a solid solution of two phthalimide derivatives in methyl methacrylate on the frequency of the exciting light and on the fluorescence frequency are presented in graphical form. The method used was described in the previous paper. F.Lachman

539.2 : 535.37

10055 THE MAXIMUM POLARIZATION OF LUMINESCENCE IN COMPLEX MOLECULES.

G.P.Gurinovich, A.M.Sarzhevskii and A.N.Sevchenko.

Optika i Spektrosk., Vol. 7, No. 5, 668-76 (Nov., 1959). In Russian.

The theory of polarized fluorescence predicts a maximum value of $P_0 = 0.5$ for polarization in isotropic solutions. In order to measure this maximum value the effect of Brownian rotational motion of molecules was eliminated by placing them in a solid solution in polymethylmethacrylate. In this way it was found that when the frequencies of excitation (ν_{exc}), of fluorescence (ν_{fl}), and of a purely electronic transition were equal, the value of P_0 in five phthalimide derivatives approached 0.5. In all cases the dependence $P_0 = f(\nu_{fl})$ was a mirror image of the dependence $P_0 = f(\nu_{exc})$, with the frequency of the purely electronic transition as a centre of symmetry. Variations in the reported values of P_0, and departures of P_0 from its theoretical limit, are due to the effect of vibrations in the ground and excited states of the molecules. A.Tybulewicz

539.2 : 535.37

10056 THE INITIAL STAGES OF DECAY IN PHOSPHORS WITH LEVELS OF SEVERAL TYPES.

V.V.Antonov-Romanovskii.

Optika i Spektrosk., Vol. 7, No. 3, 376-83 (Sept., 1959). In Russian.

It is shown that, under certain conditions, the decay curve in the initial stages can be represented as a sum of exponentials, provided that the probability of repeated capture of free charges is higher than the probability of their recombination with localized charges and provided there is no saturation. A.Tybulewicz

539.2 : 535.37

10057 LUMINESCENCE OF CRYSTALLINE ANTHRACENE AT T = 20.4°K. A.F.Prikhot'ko and I.Ya.Fugol'.

Optika i Spektrosk., Vol. 4, No. 3, 335-43 (1958). In Russian. English summary: PB 141047 T-4, obtainable from Office of Technical Services, U.S.Dept. of Commerce, Washington, D.C., U.S.A.

The luminescence and long-wavelength absorption spectra of single anthracene crystal plates have been measured at 20.4°K. Differences in luminescence spectra between specimens free from surface damage are ascribed to lattice defects, a more complex spectrum being observed with the thicker specimens. Surface-damaged specimens have a more diffuse spectrum. J.B.Birks

539.2 : 535.37

10058 EMISSION OF ACTIVATED CADMIUM SELENIDE PHOSPHORS. M.Avinor and G.Meijer.

J. chem. Phys., Vol. 32, No. 5, 1456-8 (May, 1960).

The emission bands of cadmium selenide activated by silver, copper, and gold, and coactivated by trivalent metals, were found at 0.92, 1.20 and 1.45 μ, respectively, at the temperature of liquid nitrogen. The silver band is completely quenched at room temperature. A near edge emission of CdSe was found at 0.72 μ.

539.2 : 535.37

10059 TEMPERATURE DEPENDENCE OF EDGE EMISSION IN CADMIUM SULFIDE. D.C.Reynolds.

Phys. Rev., Vol. 118, No. 2, 478-9 (April 15, 1960).

The temperature dependence of the blue and the green emission was investigated from 77° to 300°K. The blue emission shifts to longer wavelengths as the temperature is increased above 77°K with a temperature coefficient of 4.9×10^{-4} eV/°C. The intensity of the green emission falls off exponentially above 77°K with very little shift in the spectral position of the green peaks.

539.2 : 535.37

10060 ORIENTATION OF LUMINESCENCE CENTRES IN URANIUM-ACTIVATED LITHIUM FLUORIDE CRYSTALS.

P.P.Feofilov.

Optika i Spektrosk., Vol. 7, No. 6, 842-3 (Dec., 1959). In Russian.

A luminescence–polarization method of determining the orientation of luminescence centres in cubic syngony crystals was used to show that the luminescence centres in LiF:U are oriented along the fourth-order symmetry axes (C_4). From this orientation and the principle of local charge compensation, a model of a luminescence centre in LiF:U was deduced: a hexavalent uranium ion (U^{6+}) replaces isomorphously a lithium ion (Li^+) and the excess positive charge of +5 units is compensated by isomorphous substitution of five out of six fluorine ions (F^-) by oxygen ions (O^{2-}). A.Tybulewicz

539.2 : 535.37

10061 LUMINESCENCE OF LITHIUM HYDRIDE. F.F.Gavrilov.

Optika i Spektrosk., Vol. 7, No. 3, 371-5 (Sept., 1959). In Russian.

Additively and photochemically coloured lithium hydride crystals luminesced strongly when excited with light from a mercury lamp. The luminescence spectrum consisted of three bands with maxima at 5970, 6550 and 7180 A. The thermal quenching of LiH was found to obey a formula first suggested by Gurney and Mott (Abstr. 679 of 1939). Luminescence of LiH is ascribed to excess lithium, whose presence was established by chemical analysis. Other impurities help in formation of emission centres by promoting dissociation of LiH. A.Tybulewicz

539.2 : 535.37

10062 THE LUMINESCENCE OF MANGANESE ACTIVATED MAGNESIUM LITHIUM ANTIMONATE. K.T.Wilke.

Z. phys. Chem. (Leipzig), Vol. 213, No. 5-6, 298-301 (1960). In German.

An u.v. excited phosphor is described, of approximate composition 6.0 MgO. 1.3 Li_2O. 1.0 Sb_2O_5 containing 0.5% Mn. It has a structureless emission band with its peak at 6500 A, an efficiency about 1/3 of that of MgLi arsenate : Mn, and is quenched at 200°C. Its emission is 50% greater than that of the author's Al Li arsenate : Mn which has an emission band showing structure in the same region. S.T.Henderson

539.2 : 535.37

10063 THE INTRINSIC LUMINESCENCE OF CRYSTALLINE NAPHTHALENE. M.T.Shpak and E.F.Sheka.

Optika i Spektrosk., Vol. 8, No. 1, 66-72 (Jan., 1960). In Russian.

The luminescence (in the region of fundamental absorption) and absorption spectra of crystalline naphthalene were obtained at 20.4, 77, 200-210, 293 and 330-340°K. The results point to exciton nature of luminescence of very pure naphthalene crystals in the fundamental absorption region. A.Tybulewicz

539.2 : 535.37

10064 EFFECT OF METAL ATOM PERTURBATIONS ON THE LUMINESCENT SPECTRA OF PORPHYRINS.

J.B.Allison and R.S.Becker.

J. chem. Phys., Vol. 32, No. 5, 1410-17 (May, 1960).

The low-temperature emission spectra of the dimethyl ester of mesoporphyrin IX and its divalent derivatives of cobalt, nickel, copper, zinc, palladium, cadmium, and barium have been obtained. Magnesium etioporphyrin (II) and zinc phthalocyanine were also investigated. The divalent silver mesoporphyrin was also studied, but no luminescence was obtained for this compound. Considerations of the relative lifetimes of fluorescence and phosphorescence of the various derivatives permit qualitative deductions to be made regarding magnetic susceptibility. Certain qualitative information on metal-porphyrin bonding is presented based on the comparative intensities of fluorescence and phosphorescence. Anomolous emission characteristics of several of the metallo-porphyrins are tentatively interpreted in terms of crossing of a first excited state and the ground state.

539.2 : 535.37

10065 ABSORPTION AND LUMINESCENCE SPECTRA OF THE KBr(In) PHOSPHOR AND THEIR CHANGE UNDER THE ACTION OF X-RAYS. M.L.Kats and V.K.Nikol'skii.

Optika i Spektrosk., Vol. 4, No. 3, 354-7 (1958). In Russian.

English summary: PB141047T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Measurements have been made of the absorption, excitation and luminescence spectra of KBr(In) crystals and of the effect of X-ray irradiation on the absorption spectra of the phosphor. Many similarities are observed in the properties of KBr crystals activated with In^{+} and Sn^{++} ions which have iso-electron shells, indicating that the absorption is related to electronic transitions between levels of activator ions, which are displaced by the internal crystalline field. J.B.Birks

539.2 : 535.37

10066 LUMINESCENCE SPECTRA OF TRIVALENT URANIUM IONS. L.N.Galkin and P.P.Feofilov.

Optika i Spektrosk., Vol. 7, No. 6, 840-1 (Dec., 1959). In Russian.

The luminescence spectra of trivalent uranium ions in artificially grown calcium, strontium and barium fluoride monocrystals, obtained at room temperature and at −150°C, are reported and interpreted. A.Tybulewicz

539.2 : 535.37

10067 TRIPLET–SINGLET EMISSION SPECTRA OF XYLENES IN CRYSTALLINE STATE AT 4.2° AND 77°K, AND IN EPA AT 77°K. L.A.Blackwell, Y.Kanda and H.Sponer.

J. chem. Phys., Vol. 32, No. 5, 1465-76 (May, 1960).

The spectra in the crystalline state and in a rigid glass were photographed and analysed. Samples were kept sealed under an O_2-free atmosphere of helium gas throughout the experiments. Large well-formed crystals were grown from the vapour on a surface cooled by liquid nitrogen, and some were grown from the melt. At 4.2°K o-xylene produced two sharp spectra similar in structure and separated by 370 cm^{-1} from each other. These spectra are ascribed to two distinct crystalline phases. At 77°K o-xylene did not produce a significant phosphorescence. The spectrum of m-xylene at 4.2°K consisted of a strong diffuse spectrum and a weak sharp spectrum toward shorter wavelengths. The diffuse spectrum appeared to be associated with the amorphous phase. At 77°K a broad spectrum appeared which was found to be characteristic of an aldehyde. At 4.2°K, p-xylene showed a sharp spectrum beginning at 25 254 cm^{-1}. It differs in vibrational structure from the spectrum of this compound in a rigid glass. A vibrational analysis indicated that the carrier of this spectrum is p-methylbenzaldehyde. With crystals of the p-xylene grown from the melt the genuine spectrum due to p-xylene was observed between 28 246 and 25 416 cm^{-1}, overlapped by the spectrum of p-methylbenzaldehyde in the longer wavelength region. These results suggest a temperature-activated sensitization which had been first observed in toluene.

539.2 : 535.37

10068 THE LOW-TEMPERATURE LUMINESCENCE OF ZINC OXIDE IN THE RED PART OF THE SPECTRUM. V.V.Osiko.

Optika i Spektrosk., Vol. 7, No. 6, 770-5 (Dec., 1959). In Russian.

Zinc oxide heated to temperatures above 1100°C in air or oxygen luminesced on excitation with 365 mμ radiation at room temperature, emitting yellowish light. On lowering of temperature the luminescence intensity rose strongly and the emission became red in colour. This red luminescence is due to unstable stoichiometric defects in the form of excess of oxygen. Experiments on zinc oxide containing divalent Mn as an impurity showed that, although manganese entered the oxide lattice forming a substitutional structure, no manganese luminescence was observed. A.Tybulewicz

539.2 : 535.37

10069 THE EFFECT OF INFRARED LIGHT ON LUMINESCENCE OF ZnS:Mn PHOSPHORS. P.B.Yashchin [Jaszczyn].

Optika i Spektrosk., Vol. 7, No. 5, 691-6 (Nov., 1959). In Russian.

The effect of infrared illumination on the blue and orange bands in the luminescence of ZnS:Mn was studied under the conditions of steady excitation with ultraviolet light of different intensities, with different amounts of Mn and at different temperatures. The effect of infrared illumination was a superposition of two processes: liberation of holes which produced quenching and liberation of electrons which intensified luminescence. A possible mechanism of sensitization of the orange luminescence is discussed. A.Tybulewicz

539.2 : 535.37

10070 QUANTUM YIELDS OF PHOSPHORESCENCE AND FLUORESCENCE OF CERTAIN MONODERIVATIVES OF NAPHTHALENE IN SOLUTIONS AT −196°C.

V.L.Ermolaev and K.K.Svitashev.

Optika i Spektrosk., Vol. 7, No. 5, 664-7 (Nov., 1959). In Russian.

The ratio of phosphorescence and fluorescence yields in solid solutions at −196°C was measured for naphthalene, quinoline, and eight mono-derivatives of naphthalene. The values of this ratio are used to discuss internal conversion from the singlet excited to the triplet state in these molecules. A.Tybulewicz

539.2 : 535.37

10071 STEADY-STATE LUMINESCENCE OF PHOSPHORS WITH SEVERAL TYPES OF TRAPS.

V.V.Antonov-Romanovskii.

Optika i Spektrosk., Vol. 8, No. 1, 73-80 (Jan., 1960). In Russian.

Discusses kinetics of phosphorescence under steady-state excitation in the case when weakly-filled traps differ very strongly in their depths. The charge distribution in the traps is calculated, and the dependence on temperature and intensity of excitation of the charge distribution, the luminance of individual phosphorescence bands, and the photoconductivity is analysed. A.Tybulewicz

539.2 : 535.37

10072 SENSITIZED PHOSPHORESCENCE OF HALIDE PHOSPHOR CRYSTALS.

V.Ya.Kark, Ch.B.Lushchik and I.V.Yaek.

Optika i Spektrosk., Vol. 8, No. 1, 144-6 (Jan., 1960). In Russian.

The phosphorescence excitation spectrum of KBr:Tl:In was investigated and it was found that recombination luminescence of Tl and In is excited on absorption of light in Tl and In absorption bands, i.e. there was no sensitized phosphorescence. Sensitized phosphorescence was found in $CdBr_2$:Pb:Mn; after excitation of Pb^{++} ions the energy was transferred resonantly to Mn^{++} ions as a result of intermediate recombination processes. A.Tybulewicz

539.2 : 535.37 : 537.2

LUMINESCENT AFTERGLOW IN ZnS. See Abstr. 10023

539.2 : 535.37

10073 PLASTIC SCINTILLATORS WITH ADDITION OF ARYL DERIVATIVES OF 1,3,4-OXADIAZOLE.

N.P.Shimanskaya, A.P.Kilimov, A.P.Grekov, L.M.Egupova and R.S.Azen.

Optika i Spektrosk, Vol. 7, No. 3, 366-70 (Sept., 1959). In Russian.

The authors measured the scintillation efficiency and recorded the absorption and luminescence spectra of solid solutions of eight 2,5-aryl derivatives of oxadiazole in polystyrene. Of the eight compounds reported on in this paper and eight other oxadiazole derivatives, reported on earlier, the following were found to be most

efficient in polystyrene scintillators :

2,5-di-(4-biphenylyl)-1,3,4-oxadiazole (BBD);

2,5-di-(1-naphthyl)-1,3,4-oxadiazole (αNαND);

2-phenyl-5-(4-methoxyphenyl)-1,3,4-oxadiazole (MtPPD);

2-(4-biphenylyl)-5-(2-naphthyl)-1,3,4-oxadiazole (αNBD);

2-phenyl-5-(1-naphthyl)-1,3,4-oxadiazole (αNPD).

A.Tybulewicz

539.2 : 535.37

10074 INVESTIGATION OF THE LIGHT-SUMS IN THE SrS:Eu:Sm PHOSPHOR. I. I.B.Keirim-Markus.
Optika i Spektrosk., Vol. 7, No. 3, 384-97 (Sept., 1959). In Russian.

Storage of electrons, their distribution in traps and trap parameters were deduced from thermal de-excitation curves of SrS : Eu : Sm SrS:Eu:Sm phosphors. These curves were obtained as follows: the phosphor was first completely de-excited by heating to 400°C, then it was excited with light or with γ-rays (from Co^{60}) and slowly heated to 400°C. The temperature dependences of luminescence (thermal de-excitation curves) had peaks which provided the relevant information. From the absorbed γ-ray energy the light-sum energy yield, i.e. that part of excitation energy which is stored as a light-sum, was found to be 0.09. This yield remained constant up to γ-ray doses of 1200 r. From this constancy and other data it was concluded that the saturation value of the stored light-sum is governed by filling of deep traps and that the de-exciting action of γ-rays is of little importance. A.Tybulewicz

539.2 : 535.37

10075 INVESTIGATION OF LIGHT-SUMS IN THE SrS:Eu:Sm PHOSPHOR. II. I.B.Keirim-Markus.
Optika i Spektrosk., Vol. 7, No. 4, 537-41 (Oct., 1959). In Russian.

Gives a theoretical interpretation of the results reported in Pt I on light-sum storage in the SrS:Eu:Sm phosphor by γ-ray or photo-excitation; the linear dependence of the stored light-sum on the γ-ray dose is discussed in detail. A.Tybulewicz

539.2 : 535.37

10076 THE EFFECT OF FAST ELECTRONS ON THE STORED LIGHT-SUM IN CATHODOLUMINESCENCE. Yu.M.Popov.
Optika i Spektrosk., Vol. 7, No. 5, 697-702 (Nov., 1959). In Russian.

The possibility of knocking out electrons from trapping levels by the fast electrons, formed by ionization losses of an electron beam in a phosphor, is discussed. The density of the electron beam is calculated at which the probability of transfer of electrons from deep trapping levels into the conduction band is comparable with thermal ejection; such a density is shown to be quite possible in practice. A.Tybulewicz

539.2 : 535.37

10077 TEMPERATURE QUENCHING IN CERTAIN ORGANIC SCINTILLATORS. A.F.Kulakova and I.M.Rozman.
Optika i Spektrosk., Vol. 8, No. 1, 140-2 (Jan., 1960). In Russian.

Galanin (Abstr. 12122 of 1959) suggested that the radioluminescence yield of α-particles is lower than the yield of β-particles because of very strong temperature quenching in the central portions of the α-particle tracks. The present authors found that the temperature dependence of α- and β-luminescence of dibenzyl and stilbene bore out Galanin's theory but this theory was not obeyed by toluene, xylene, styrene, benzene and other low-melting point scintillators. A.Tybulewicz

539.2 : 535.37

10078 THE SCINTILLATION BEHAVIOUR OF SOME INORGANIC PHOSPHORS AT LOW TEMPERATURE.
R.Langkau.
Z. Naturforsch., Vol. 15a, No. 4, 364 (April, 1960). In German.

The decay of scintillations induced by 4 MeV α-particles in ZnS:Ag and ZnO is resolved into three exponentials. For ZnS:Ag, the effect of cooling from room temperature to −195°C is to reduce the proportion and the time constant of the slowest component. For ZnO the intermediate component is slower and more prominent at low temperature, while for $CaWO_4$ the single and much slower exponential decay process changes from 4.1 to 6.8 μsec on cooling.
S.T.Henderson

539.2 : 535.37 : 539.12

GAMMA ABSORPTION IN NaI:Tl. See Abstr. 9326

539.2 : 535.37

10079 ON THE GROUPING OF ELECTROLUMINESCENT EFFECTS. J.Weiszburg.
Acta. phys. Hungar., Vol. 10, No. 3, 337-40 (1959).

The similarities and differences of "carrier injection" electroluminescence and "intrinsic" electroluminescence are discussed in terms of polarity of exciting voltage, rectification, emission spectra, field strength, and several other features. The author finds no very real differences between the phenomena and raises the question of whether a distinction in terminology is justified. I.Cooke

539.2 : 535.37

10080 INVESTIGATION OF ELECTROLUMINESCENCE OF ZnS:Cu MONOCRYSTALS.
V.E.Oranovskii and B.A.Khmelinin.
Optika i Spektrosk., Vol. 7, No. 4, 542-6 (Oct., 1959). In Russian.

Properties of long, narrow regions, known as "dashes", in electroluminescent ZnS:Cu monocrystals were studied Observations of brightness (luminance) waves from various sectors of a "dash" and studies of the effect of an ultraviolet light spot on these waves showed that excitation and emission processes occur throughout each "dash". Sectors of a "dash" are regions of p- or n-type conductivity. It was also found that electroluminescence can be produced by field intensities not greater than 10^4 V/cm.
A.Tybulewicz

539.2 : 535.37

10081 SPECTRAL CHARACTERISTICS OF ELECTROLUMINESCENCE OF CERTAIN PHOSPHORS UNDER THE CONDITIONS OF SIMULTANEOUS ACTION OF DIRECT AND ALTERNATING FIELDS. V.N.Favorin, G.S.Kozina and L.K.Tikhonova.
Optika i Spektrosk., Vol. 7, No. 5, 703-5 (Nov., 1959). In Russian.

Two-colour phosphors of ZnS:Cu:Mn type, which emit green and yellow bands in alternating fields, as well as mixtures of one-colour phosphors, have different electroluminescence spectra in direct and in alternating fields. When the direct and alternating fields are applied together a rise of intensity is observed in the yellow region and the intensity of this yellow luminescence is higher than the sum of intensities due to the action of direct and alternating fields separately; the exact colour of electroluminescence depends on the ratio of the d.c. and a.c. fields. A.Tybulewicz

539.2 : 535.37

10082 DEPENDENCE OF THE ELECTROLUMINESCENCE SPECTRA OF CERTAIN PHOSPHORS ON THE ALTERNATING-FIELD INTENSITY.
V.N.Favorin and L.P.Poskacheeva.
Optika i Spektrosk., Vol. 7, No. 5, 706-9 (Nov., 1959). In Russian.

Reports a study of the luminescence spectra of two-colour ZnS:Cu:Mn phosphors and of mixtures of green (ZnS:Cu) and yellow (ZnS:Cu:Mn) phosphors in alternating fields. The intensity of the yellow band, due to manganese, rises more rapidly with the applied voltage than that of the green band, due to copper. The lack of interaction between the green and yellow centres is due to the difference of the de-excitation mechanisms of the two types of centres. A.Tybulewicz

539.2 : 535.37

10083 ELECTROLUMINESCENCE OF ZnS:Cu:Mn PHOSPHORS IN A CONSTANT FIELD.
O.N.Kazankin, F.M.Pekerman and L.N.Petoshina.
Optika i Spektrosk., Vol. 7, No. 6, 776-9 (Dec., 1959). In Russian.

ZnS:Cu:Mn phosphors (with 0.05-0.3% Cu and 0-3.0% Mn) prepared in an atmosphere of H_2S + HCl, using a technique described in Abstr. 10853 of 1959, exhibited strong luminescence in constant (d.c.) fields. The two conditions for d.c. electroluminescence were: (i) the presence of Mn (at least 0.1% was required); and (ii) the presence of Cu as Cu_2S, which raised the electrical conductivity of the phosphor very considerably. The time dependence of the d.c. luminescence was also affected by the amounts of Cu and Mn in the phosphor. A.Tybulewicz

539.2 : 535.37 : 537.312

10084 EFFECT OF PULVERIZATION ON THE OPTICAL AND ELECTRICAL PROPERTIES OF CERTAIN ZnS PHOSPHORS. É.V.Stauér and M.G.Rozenblat.
Optika i Spektrosk., Vol. 7, No. 4, 570-1 (Oct., 1959). In Russian.

Pulverization of ZnS : Cu, ZnS : Cu : Al, ZnS : Cu : Mn and other phosphors reduced the intensity of both photoluminescence and electroluminescence, produced displacement of the electroluminescence spectrum towards longer wavelengths and fall of the temperatures at which quenching of electroluminescence began. After pulverization the real and imaginary parts of complex permittivity (ϵ' and ϵ'') decreased, dependences of ϵ' and ϵ'' on the applied-field frequency and intensity and on temperature became less pronounced, the dark and photoconductivities decreased and the ratio of photoconductivity to dark conductivity fell. All these changes are due to the change in the particle dimensions and due to the effect of deformations produced during grinding. A.Tybulewicz

539.2 : 535.37 : 621.383.2

10085 LIGHT PATTERNS OF ELECTROLUMINESCENT PANELS. Z.Bodó and J.Weiszburg.
Acta phys. Hungar., Vol. 10, No. 3, 341-3 (1959).

Using a photographic technique to integrate the light emitted over a period of time ranging from 8 to 24 hrs, experiments have been performed to identify the position of light emitting regions in electroluminescent ZnS:Cu panels. It was concluded that every light spot was emitted with both polarities of the applied field, although in some cases there was a great difference in intensity with reversal. The difference in intensity upon reversal of the field is explained by grain orientation and/or by asymmetric properties of the lighting regions themselves. I.Cooke

539.2 : 535.37 : 621.383.2

10086 THE EFFECT OF ELECTRICAL PRE-HISTORY OF AN ELECTROLUMINESCENT PHOSPHOR ON THE CHARACTERISTICS OF ITS EMISSION WHEN EXCITED WITH SHORT VOLTAGE PULSES. I.Ya.Lyamichev and I.N.Orlov.
Optika i Spektrosk., Vol. 7, No. 3, 398-406 (Sept., 1959). In Russian.

Phosphors of ZnS:Cu(Pb,Cl) and ZnS:Cu:Cl types were excited with square voltage-pulses from a special generator which produced several independently controlled series of pulses. Each voltage pulse produced a light pulse consisting of two peaks. The mechanism of formation of these peaks is discussed in terms of electrical pre-history; in the case of pulse excitation such pre-history means the duration, period, amplitude etc. of pulses up to a given moment. A.Tybulewicz

539.2 : 535.37 : 537.533

ELECTROLUMINESCENCE OF ANODIC Al OXIDE: ASSOCIATION WITH EXO-ELECTRON EMISSION. See Abstr. 9065

550.3 : 539.2 : 535.37

PRESSURE EFFECTS ON THERMOLUMINESCENCE OF LIMESTONE RELATIVE TO GEOLOGIC AGE. See Abstr. 10087

539.2 : 535.37 : 550.3

10087 PRESSURE EFFECTS ON THERMOLUMINESCENCE OF LIMESTONE RELATIVE TO GEOLOGIC AGE. E.E.Angino.
J. geophys. Res., Vol. 64, No. 5, 569-73 (May, 1959).

Thermoluminescence as modified by pressure has been studied, and a relationship between pressure effects and geologic age has been observed. Experimental evidence indicates that the amount of pressure and the length of time that it is applied cause a marked variation in the ratio of thermoluminescence of pressed to unpressed samples. Geologically young samples showed a greater variability in the induced time–pressure effects than did geologically older samples. The ratio of thermoluminescence of pressed to unpressed samples plotted against the time the pressure was applied showed a systematic variation from low values through a pronounced maximum and back to intermediate values. The amplitude of this curve shows an inverse relationship to the geologic age of the sample for limestones younger than Mesozoic.

539.2 : 535.37

10088 SOME EFFECTS OF PRESSURE ON THE THERMOLUMINESCENCE OF LIMESTONE. E.E.Angino.
J. geophys. Res., Vol. 64, No. 10, 1638-40 (Oct., 1959).

Some samples of limestone, preheated to remove thermoluminescence, developed it again after pressure at ~7500 atm. The induced emission occurred between 300° and 350°C and in one case was as large as the natural thermoluminescence. S.T.Henderson

539.2 : 535.37

10089 INVESTIGATION OF THE ENERGY OF THERMAL ACTIVATION OF THE OPTICAL FLASH IN ZnS:Cu:Pb PHOSPHORS. V.L.Levshin and B.M.Orlov.
Optika i Spektrosk., Vol. 7, No. 4, 530-6 (Oct., 1959). In Russian.

Deals with stimulation of the optical flash in ZnS:Cu:Pb phosphors by infrared light of ~ 1 μ wavelength. It was found that to liberate electrons from localization levels it is necessary to activate them thermally first The energy of thermal activation depended on the nature of the localization levels and was independent of the wavelength of the stimulating light. A.Tybulewicz

MAGNETIC PROPERTIES OF SOLIDS

539.2 : 538.2

10090 EFFECT OF UNIAXIAL COMPRESSION ON THE QUANTUM OSCILLATIONS OF THE MAGNETIC SUSCEPTIBILITY OF BISMUTH. N.B.Brandt and G.A.Ryabenko.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 389-91 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 278-9 (Feb., 1960).

The effect of uniaxial compression along the trigonal axis, using pressures up to 340 kg/cm², on the frequency and amplitude of the quantum oscillations of the magnetic susceptibility of bismuth was investigated for temperatures between 1.6 and 4.2° K. The results obtained are discussed on the basis of the semi-phenomenological theory of Kosevich (Abstr. 2917 of 1959).

539.2 : 538.2

10091 SATURATION MAGNETIZATION AND MOLECULAR FIELDS OF THE ACETYLACETONATES OF CHROMIUM AND IRON. W.E.Henry.
Physica, Vol. 24, Supplement, S160 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Previous work (Abstr. 7558 of 1954) on the dependency of magnetization (M) on magnetic field and temperature up to magnetic saturation (1.3°K and 60 000 gauss) provided molecular field values for paramagnetic ions; e.g., antiferromagnetic (negative) molecular fields for manganous chloride tetrahydrate and ferromagnetic (positive) molecular fields for $CrCl_3$. In this investigation M(H/T) has been determined for chromium acetylacetonate and ferric acetylacetonate in this framework up to saturation and the results compare with magnetically dilute compounds of the same ions so as to obtain the sign and magnitude of the interactions. For chromium acetylacetonate, the saturation magnetization is near three Bohr magnetons per atom of chromium. The molecular field opposes the applied field and the antiferromagnetic molecular field is about 4000 G. The corresponding values for ferric acetylacetonate are about 5 Bohr magnetons per atom of iron and 5500 G. The data suggests an approaching antiferromagnetic type transition at lower temperatures.

539.2 : 538.2 : 537.3

10092 ELECTRICAL AND MAGNETIC BEHAVIOR OF DILUTE ALLOYS: Co IN Cu, Mn IN Cu.
I.S Jacobs and R.W.Schmitt.
Physica, Vol. 24, Supplement, S174 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The magnetoresistance and magnetization of solid solutions of 0.5, 1.0 and 2.0 at. % Co in Cu obey the relation, $\Delta\rho = bσ^2$, found previously for Cu(Mn) alloys [J. Phys. Chem. Solids, Vol. 3, 324 (1959)], with b temperature independent in contrast to that for Cu (Mn). The low temperature resistivity of the Cu (Co) alloys increases with decreasing temperature and no maximum occurs down to 1.6° K. The magnetization of the Cu(Co) alloys shows neither remanence nor hysteresis but is non-linear with field. The isothermal remanence at 4.2° K of a 1.8 at. % Mn in Cu alloy saturates at about 3×10^{-3} (μ_B/Mn atom) after fields less than 20 kOe, does not increase after pulsed fields up to 140 kOe. It is equal to the saturation thermoremanence obtained after cooling in fields ≥ 1.5 kOe. Both remanences reverse in relatively low fields (≈ 2 kOe). The results indicate a cooperative magnetic state for Cu (Mn) while the results for Cu(Co) are inconclusive in this respect.

539.2 : 538.2

10093 MAGNETIC AND THERMODYNAMIC PROPERTIES OF COPPER II ACETONYLACETONE.

J.J.Fritz and R.G.Taylor.

Physica, Vol. 24, Supplement, S160 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The magnetic and thermodynamic properties of the copper (II) chelate of acetonylacetone have been measured from 1.0° to 20°K. There is a small but sharp maximum in the zero-field heat capacity at about 1.25°K, below which the specimen absorbs energy from an alternating magnetic field. The total magnetic entropy removed down to 1.0°K is only about 10% of the R ln 2 expected at high temperatures. Above 2°K, the magnetic susceptibility follows a Curie–Weiss Law.

539.2 : 538.2 : 536.48

PARAMAGNETIC EFFECT IN SUPERCONDUCTORS AT LOW VALUES OF THE EXTERNAL FIELD. See Abstr. 8951

539.2 : 538.2

10094 SUSCEPTIBILITY AND SPECIFIC HEAT OF DYSPROSIUM ETHYL SULPHATE BELOW 1°K.

A.H.Cooke, D.T.Edmonds and W.P.Wolf.

Physica, Vol. 24, Supplement, S160 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Accurate measurements of the susceptibility of a single crystal sphere of $Dy(C_2H_5SO_4)_3 9H_2O$ have been made from 1°K to 0.12°K. The temperature in these experiments was determined from the measured susceptibility of a single crystal sphere of cerium magnesium nitrate in good thermal contact with the specimen. The susceptibility showed considerable deviation from Curie's law which can be accounted for almost entirely by magnetic dipole–dipole interaction using a model of loosely coupled Ising chains. At 0.136°K there is a maximum in the susceptibility corresponding to a value of $T^* = 0.126°$. The specific heat of the isolated sphere of $Dy(C_2H_5SO_4)_3 9H_2O$ was measured between $T^* = 0.05°$ and $T^* = 0.7°$ using γ-ray heating, electrical heating and audiofrequency relaxation heating. The results by the three methods were in excellent agreement. Direct S–T* measurements were also made using fields of up to 10 kG to extract 98% of the electronic entropy. S at the minimum T* was 1/3 R ln 2. Preliminary measurements on a 2 : 1 ellipsoid have been made.

539.2 : 538.2

10095 THE MAGNETIC SUSCEPTIBILITY AND RELAXATION OF A $MnCl_2 \cdot 4H_2O$ SINGLE CRYSTALS IN THE PARAMAGNETIC AND ANTIFERROMAGNETIC STATES.

M.A.Lasheen, J.van den Broek and C.J.Gorter.

Physica, Vol. 24, No. 12, 1061-75 (Dec., 1958).

Susceptibility measurements show isotropic paramagnetic behaviour following a Curie–Weiss Law in the liquid hydrogen region, and in the liquid helium region above 1.7°K., at which temperature the crystal becomes anisotropic. At the Néel temperature, 1.62°K., the susceptibility in the b-direction exhibits a maximum and in the c-direction decreases rapidly. The susceptibility behaviour in the antiferromagnetic state is in general agreement with the molecular field theory. Relaxation measurements made at frequencies below 1135 c/s, show that below the lambda point in liquid helium good agreement is obtained with the Casimir–du Pré theoretical dispersion and absorption curves; above this temperature, however, there is considerable deviation due to limited heat conduction in the crystal. The relaxation parameters are independent of magnetic field, and vary inversely with the fourth power of temperature. Specific heat values for the spin system have been derived. Below 2°K they are in good agreement with directly obtained values; above 2°K they are inversely proportional to the square of the temperature. S.A.Ahern

539.2 : 538.2

10096 ADIABATIC DEMAGNETIZATION OF $MnSiF_6 \cdot 6H_2O$.

A.Ohtsubo, T.Haseda and E.Kanda.

Physica, Vol. 24, Supplement, S161 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Adiabatic demagnetization has been carried out on a spherical single crystal of $MnSiF_6 \cdot 6H_2O$. The curve of a.c. susceptibility v. entropy shows a maximum χ' parallel to the hexagonal axis is much larger than χ' perpendicular to the axis, and the maximum of the former is much more pronounced. A very sharp maximum of χ'' was observed near the entropy of the maximum χ'. The Curie point, determined by χ''-heating, is about 0.1°K. From the field dependence of the susceptibility, the magnetization curves v. the magnetic field and v. the entropy were determined. From the positive $(\partial M/\partial S)_H$ and the linear magnetization for magnetic field vertical to this axis, it is deduced that the spin ordered state below 0.1°K is antiferromagnetic and that the preferred axis is along the hexagonal axis. These results are discussed in connection with the columnar structure of the crystal.

539.2 : 538.2

10097 THE MAGNETIC SUSCEPTIBILITY OF NITRIC OXIDE IN A CLATHRATE COMPOUND. J.H.Van Vleck.

Physica, Vol. 24, Supplement, S161 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Recent unpublished measurements of Cooke and Meyer show that the susceptibility of NO in β quinol clathrate is practically constant between 1°K and 20°K and about 40% higher than for the free molecule. It falls off gradually to the free value as the temperature is raised above 20°K. This result poses a difficult problem, as most crystalline potentials V, e.g., rhombic fields, create a large Kramers doublet term in 1/T, contrary to experiment. The observed behaviour is explicable if, and probably only if, V has a large trigonal term, which creates a sort of Jahn–Teller effect. This situation can arise if the equilibrium position of the molecule is a body diagonal of a substantially cubic potential. With the author's model, the quadrupole moment of the magnetic p_π electron is comparable with the of the whole molecule, and the Kramers doublet verges on detectability.

539.2 : 538.2

10098 PARAMAGNETIC SUSCEPTIBILITY OF RUBY AT LOW TEMPERATURES.

K.Brugger, H.L.Davis and J.G Daunt.

Physica, Vol. 24, Supplement, S159 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The paramagnetic susceptibility of a synthentic ruby single crystal with 0.614 ± 0.06% chromium by weight has been measured as function of the angle between the trigonal symmetry axis and the direction of the measuring field, and as function of the temperature in the liquid helium range. Writing the susceptibility in a direction x as power series

$$\chi_x = \frac{c_x}{T}\left(1 + \frac{\Delta_x}{T} + \frac{\Gamma_x}{T^2} + \ldots\right)$$

the experimental results are given by $c_\parallel = (7.32 \pm 0.35) \times 10^{-4}$ emu/cm^3, $c_\perp = (7.40 \pm 0.35) \times 10^{-4}$ emu/cm^3, $\Delta_\parallel = 0.214 \pm 0.02°$K, $\Delta_\perp = 0.095 \pm 0.05°$K and $\Gamma_\parallel$, $\Gamma_\perp \cong 0$. The free Cr^{3+} ion in a F^4 state, which is split into two doublets and three singlets by the trigonal electric field of the surrounding oxygen octahedron. In order to obtain agreement with the experiment it has to be assumed that a singlet lies lowest. The deviations from Curie's law are caused by the Stark splitting of the four-fold degenerate ground state. The susceptibility was calculated using Broer's expressions for the energies of the spin levels of the ground state, containing the zero field splitting between the Kramers doublets as parameter. Using Geusic's (Abstr. 6018 of 1956) results obtained from paramagnetic resonance at room temperature good agreement between experimental and theoretical values of Δ and Γ is obtained.

539.2 : 538.2

10099 MAGNETIC SUSCEPTIBILITY OF ELECTRONS AND DONORS IN N-TYPE SILICON.

E.Sonder and D.K.Stevens.

Physica, Vol. 24, Supplement, S162 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The magnetic susceptibility χ of silicon has been measured as a function of temperature (3°K to 300°K) for a range of donor concentrations (3×10^{16} to 3×10^{19} cm^{-3}). The donor concentrations were obtained from Hall coefficient measurements on companion specimens. The contribution to χ from conduction electrons and neutral donors were determined by subtracting the susceptibility of high-purity silicon. The difference, $\Delta\chi$, shows two ranges of behaviour: at high temperature $\Delta\chi$ is dominated by the orbital diamagnetism of conduction electrons and its value indicates a squared-reciprocal-mass ratio of 8 as compared to 12 expected from cyclotron resonance. At low temperatures $\Delta\chi$ is governed by occupied donors; higher purity specimens show a simple Curie law dependence whose slope is proportional to the donor concentration. At the higher donor concentrations interaction between donor atoms (impurity banding) causes a deviation from Curie's law.

539.2 : 538.2

10100 MEASUREMENTS ON THE MAGNETIC SUSCEPTIBILITIES OF AgMn AND CuMn ALLOYS.

A.Van Itterbeek, W.Polluntier and G.Peelaerts.
Physica, Vol.24, Supplement, S162 (Sept., 1958).

Low Temperature Physics Conference (see Abstr.7017 of 1960). Brief note, substantially as follows: Measurements have been carried out on alloys of AgMn and CuMn with different concentrations of manganese between room temperature and liquid hydrogen temperatures. A paramagnetic behaviour has been found. The dependence of the susceptibilities on the field strength was assumed but no field dependence could be detected except in some of the AgMn alloys, but this effect originated from small ferromagnetic impurities, which were determined by means of the method of Honda. The concentration of the manganese has been determined magnetically and compared with determinations based on the electrical resistance.

539.2 : 538.2

10101 MEASUREMENT OF THE SUSCEPTIBILITIES OF VARIOUS VANADIUM OXIDES AND THEIR TEMPERATURE VARIATION. J.Roch.
C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2167-9 (March 21, 1960). In French.

The temperature variation was measured between 100° and 373° K for the oxides V_2O_3, V_2O_4. nH_2O(n = 0, 1, 2), V_2O_5 and mixtures.
E.P.Wohlfarth

539.2 : 538.2

10102 THERMAL AND MAGNETIC PROPERTIES OF CERIUM ETHYL SULPHATE BETWEEN 0.02 AND 1° K.

C.E.Johnson and H.Meyer.
Proc. Roy. Soc. A, Vol. 253, 199-211 (Nov. 24, 1959).

Adiabatic demagnetization experiments were carried out on a spherical single crystal of cerium ethyl sulphate. The absolute temperature scale was determined down to 0.02° K as a function of the entropy. Measurements were also made of the adiabatic susceptibility in the antiferromagnetic state which sets in at 0.05° K and by extrapolation the magnetization at T = 0° K could be estimated to a fair accuracy. The co-operative phenomena are discussed in terms of the theory of electric quadrupole–quadrupole interaction by Finkelstein.

539.2 : 538.2 : 536.48

10103 RECENT RESULTS FROM MEASUREMENTS OF MAGNETIC TEMPERATURES BETWEEN 1 AND 24° K.

M.Durieux and H.van Dijk.
Physica, Vol. 24, Supplement, S139 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The susceptibilities of two paramagnetic salts have been measured as a function of the saturated vapour pressure in the liquid region up to the critical point and at liquid hydrogen temperatures. The susceptibilities were measured with a Hartshorn mutual inductance bridge. For information temperature scale it was assumed that the measured number of turns has the temperature dependence n = A + B/(T + Δ) and determined the constants A, B and Δ by choosing fixed values for the normal boiling points of He and H_2 and for the pT-relation in the neighbourhood of the λ-point. In this way a pT-relation for the saturated vapour of He^4 was obtained from the mutual inductance that differs slightly from $T_{L\,55}$ and T_{1958}. $Mn(NH_4)_2(SO_4)_2.6H_2O$ and $KCr(SO_4)_2.12H_2O$ were used and within the experimental limit (0.001°) the same results were found for both salts.

539.2 : 538.2

10104 EFFECT OF DIRECTIONAL ORIENTATION ON THE MAGNETIC PROPERTIES OF CUBE-ORIENTED MAGNETIC SHEETS. K.Foster and J.J.Kramer.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 233S-234S (May, 1960).

An investigation of the effect of directional orientation on the d.c. magnetic properties of cube-oriented ([001] (100) textured) 3% silicon iron sheets has been made. Induction values for a field of 10 Oe (B_{10}) followed the relationship

$$B_{10} = B_s/(\cos\theta + \sin\theta),$$

where B_s is the saturation induction and θ is the average deviation of the ⟨100⟩ direction from the rolling direction. A plot of B_{10} values as a function of the percent of grains with a ⟨100⟩ direction within 10° of the rolling direction showed that very good directional orientation is required to obtain high B_{10} values.

539.2 : 538.2

10105 EFFECT OF ATOMIC ORDERING ON EXCHANGE INTERACTION IN THE Fe_3Pt ALLOY.

K.P.Belov and Z.D.Sirota.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1058-62 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 752-4 (Oct., 1959).

The magnitude of the shift of the Curie point due to pressure and spontaneous deformation of the lattice is computed from the data on the measurement of the temperature dependence of magnetostriction in an alloy close to Fe_3Pt. It has been found that these quantities decrease with atomic ordering in the alloy. It is concluded that atomic ordering in the Fe_3Pt not only changes the magnitude of exchange interaction but also the nature of its dependence on the interatomic distance.

539.2 : 538.2

10106 THE MAGNETIZATION AND MAGNETOCALORIC EFFECT OF MANGANESE PHOSPHIDE.

I.G.Fakidov and V.P.Krasovskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1063-7 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 755-8 (Oct., 1959).

Investigated at various field strengths in the temperature region of magnetic transformations. In contrast with Guillaud (1947), it was found that the magnetic transformation temperature was not dependent on the magnetic field strength. The character of the dependence of magnetocaloric effect on the temperature and magnetic field strength and also the temperature dependence of the spontaneous magnetization indicate the existence of a Curie point at 22° C. The results obtained are discussed from the viewpoint of the s–d exchange model of ferromagnetism.

539.2 : 538.2 : 537.32

THE CURIE POINT OF MnP. See Abstr. 10008

539.2 : 538.2

10107 THE REDUCTION OF THE CURIE TEMPERATURE OF SUPERPARAMAGNETIC NICKEL CRYSTALLITES.

D.Schultze.
Naturwissenschaften, Vol. 47, No. 6, 128 (1960). In German.

The Curie temperature of nickel particles in silica gel decreases from the bulk value at a diameter of about 250 A to about 300° K at a diameter of 25 A.
E.P.Wohlfarth

539.2 : 538.2

10108 THERMOREMANENT AND ISOTHERMAL REMANENT MAGNETIZATIONS OF THE ALLOY Pd_3Mn_2.

R.Wendling.
C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2173-5 (March 21, 1960). In French.

This alloy is ferromagnetic when ordered, a state produced by heat treatment. Its remanences were measured as dependent on the annealing temperature, magnetic field strength and time. See also Burger, Wendling and Wucher [J. Phys. Radium, Vol. 20, 427 (1959)].
E.P.Wohlfarth

539.2 : 538.2

10109 CHARACTERISTICS OF SUPERMENDUR AT 500° C.

M.Lauriente and G.E.Lynn.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 237S-238S (May, 1960).

An anomalous transient effect in Supermendur material is dramatically displayed when the magnetic properties of toroidal tape cores of the material are measured at temperatures between 500 and 600° C on a constant current flux reset tester. This test is designed to simulate the action of a half-wave self-saturating magnetic amplifier. Normally a steady-state cyclic flux change is achieved within one cycle of the applied alternating magnetizing field. A transient lasting several minutes (equivalent to several thousand cycles of alternating field) was observed instead for this alloy. When measured at room temperature after exposure to extreme temperatures the magnetic properties are observed to be degraded from the properties measured at room temperature before exposure. No direct evidence has been found to show that these two phenomena are related since specimens exposed to temperatures insufficient to cause the transient were observed to sustain some degradation in room temperature properties. The contributions of various mechanisms were investigated by environmental control. The most probable causes of the degradation of properties after high temperature exposure were concluded to be oxidation and relaxation of oriented domains.

539.2 : 538.2

10110 CONNECTION BETWEEN STRUCTURAL AND MAGNETIC PARAMETERS OF THE TRANSITION METALS.

F.M.Gal'perin.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1212-23 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 862-70 (Oct., 1959).

The connection between the structural parameters (type of lattice, interatomic distances, coordinational number, etc.) and the magnetic parameters (atomic magnetic moment, Curie point, Curie constant) is considered for the pure transition elements Cr, Mn, Fe, Co, and Ni, as well as for a number of their ferromagnetic ordered alloys and chemical compounds. These relations and the available experimental data on the crystalline and electronic structures of the metals are used to compute the magnetic parameters, which are found to be in good agreement with the experiments.

539.2 : 538.2 : 536.48

10111 RELATIONS BETWEEN SUPERCONDUCTORS AND FERROMAGNETS. B.Matthias.

J. appl. Phys.,Suppl. to Vol. 31, No. 5, 23S-26S (May, 1960).

Ferromagnetic interactions of the rare earth elements in dilute solutions or in compounds with nonmagnetic elements have been discovered and are described. The Curie points are essentially proportional to the spin while the saturation moment follows the value for the effective moment. This ferromagnetic interaction, known to take place via the conduction electrons, follows criteria resembling closely those for the occurrence of superconductivity. It is shown that by suitable combination of similar superconductors and ferromagnets both phenomena can happen simultaneously in the same crystal.

539.2 : 538.2

10112 THERMOREMANENT MAGNETIZATION AND ANISOTROPY IN CrSb.

R.Wendling and J.Wucher.

C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2691-3 (April 11, 1960). In French.

Single crystals were obtained by the single passage of molten zone. These crystals possess a magnetic axis of symmetry parallel to the furnace tube, the susceptibility being a minimum along this axis. Results are given for the variation of the susceptibility with temperature. Quenching a specimen from a given temperature t°C in an applied magnetic field produces the so-called thermoremanence The dependence of this quantity on t is described.

D.J.Oliver

539.2 : 538.2

10113 TEMPERATURE DEPENDENCE OF ANISOTROPY AND SATURATION MAGNETIZATION IN IRON AND IRON–SILICON ALLOYS. C.D.Graham, Jr.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 150S-151S (May, 1960).

The temperature dependence of the magnetocrystalline anisotropy constant K_1 and of the saturation magnetization have been measured from 77 to 575°K on single-crystal samples of iron, 3.2% silicon–iron, and 5.1% silicon–iron. For iron and 3.2% Si–Fe, the anisotropy decreases as the third or fourth power of the magnetization at low temperatures; this increases to approximately the ninth power at high temperatures. The anisotropy of 5.1% Si–Fe decreases as the seventh or eighth power of the magnetization at low temperatures, and as the ninth power at high temperature.

539.2 : 538.2

10114 CRYSTAL DISTORTION IN MAGNETIC COMPOUNDS. J.Kanamori.

J. appl. Phys.,Suppl. to Vol. 31, No. 5, 14S-23S (May, 1960).

The crystal distortion which arises from the Jahn-Teller effect is discussed in several examples. In the case of compounds containing Cu^{2+} or Mn^{3+} at octahedral sites, the lowest orbital level of these ions is doubly degenerate in the undistorted structure, and there is no spin-orbit coupling in this level. It is shown that, introducing a fictitious spin to specify the degenerate orbital states, the problem can be discussed by analogy with the magnetic problems. The "ferromagnetic" and "antiferromagnetic" distortions are discussed in detail. The transition from the distorted to the undistorted structure is of the first kind for the former and of the second kind for the latter. Higher approximations are discussed briefly. In compounds like FeO, CoO, and $CuCr_2O_4$, the lowest orbital level is triply degenerate, and the spin-orbit coupling is present in this level. In this case the distortion is dependent on the magnitude of the spin-orbit coupling relative to the strength of the Jahn-Teller effect term. The distortion at absolute zero temperature and its temperature dependence are discussed.

539.2 : 538.2

10115 MAGNETIC ANISOTROPY IN SINGLE-CRYSTAL THIN FILMS. E.L.Boyd.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 116-29 (April, 1960).

Thin, single-crystal films of Ni, Fe, Ni–Fe and Ni–Co have been grown by vacuum deposition onto heated rock salt. The cubic crystalline anisotropy constant, K_1, of these films has been measured at room temperature by a torque method. In the case of the Ni–Fe alloys, K_1 was found to be the same for thin films as for bulk materials of the same composition. The measured anisotropy in the Ni–Co films differs quantitatively but has the same qualitative variation with composition as is reported for bulk crystals. The results of one magnetic annealing experiment on a 75% Ni–25%Fe film lends support to the short-range ordering model of uniaxial anisotropy in alloys. Pure nickel films exhibit a pronounced uniaxial anisotropy superimposed on the crystalline anisotropy. This uniaxial term disappears after the film is removed from the substrate, indicating that its origin is in an anisotropic stress in the deposited film.

539.2 : 538.2

10116 ANISOTROPIC MAGNETIZATION. E.R.Callen.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 149S-150S (May, 1960).

In the presence of magnetocrystalline anisotropy the magnetization of a ferromagnet depends upon its orientation as well as upon the temperature. The temperature dependences of the anisotropic parts of the magnetization have been worked out, both classically and quantum-mechanically, for all symmetries and for ferro- and ferrimagnets in the internal field approximation. The non-spherical terms are small at all temperatures in iron and nickel but are appreciable in some uniaxial materials, and very large in many crystals of low Curie point and large anisotropy. In these materials the magnetization will be very unlike a Brillouin function.

539.2 : 538.2

10117 "INTERACTION ANISOTROPY" MODEL OF THE STRUCTURE OF ALNICO MAGNET ALLOYS.

T.O.Paine and F.E.Luborsky.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 78S-80S (May, 1960).

The permanent magnet properties of Alnico alloys have been attributed to the shape anisotropy of an elongated single domain magnetic precipitate oriented by cooling in a field. This paper reports measurements of the angular variation of the magnetic properties of highly directional crystal-oriented Alnico 5 DG, Columax, and Ticonal XX which are inconsistent with the simple shape anisotropy model. A domain "interaction anisotropy" model is proposed which treats the structure as a complex interconnected single domain network. The interaction between single domain elements within this structure minimizes magnetostatic and exchange energy by introducing local variations in particle domain configuration; these nucleate buckling magnetization reversal at particle irregularities and cross-links. In its simplest form this structure can be visualized as a series of H-shaped single domain size units. The rather complex behaviour of such a structure has been analysed by measuring the magnetic properties of analogous physical models consisting of arrays of pivoted magnets. This analysis suggests that the progressive increase in maximum energy product from 6×10^6 G-Oe for Alnico 5 DG and 8×10^6 G-Oe for Columax to 12×10^6 G-Oe for Ticonal XX is associated with the suppression of buckling through the reduction of particle irregularities and cross-links. Electron micrographs of the structures of these materials and their observed angular variation of magnetic properties are consistent with this new model.

539.2 : 538.2

10118 MAGNETIC ANISOTROPY AND MAGNETOSTRICTION OF ORDERED AND DISORDERED COBALT-IRON ALLOYS. R.C.Hall.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 157S-158S (May, 1960).

The magnetic anisotropy and magnetostriction of single crystals of alloys between 25 wt. % and 59 wt. % cobalt in iron have been determined in the disordered and ordered states. The magnetostriction is large and positive for all alloys in both states of order

(up to 150×10^{-6} for λ_{100} and 40×10^{-6} for λ_{111}). The magnetic anisotropy becomes zero near 41% Co for the disordered state. Ordering shifts the zero-anisotropy composition to about 50% Co.

539.2 : 538.2

10119 A COMPARISON OF STATIC AND MICROWAVE MEASUREMENTS OF MAGNETOCRYSTALLINE ANISOTROPY IN COBALT MANGANESE FERRITE.
R.F.Pearson and R.W.Teale.
Proc. Phys. Soc., Vol. 75, Pt 2, 314-16 (Feb., 1960).

The difference in the values of the anisotropy constants obtained by microwave resonance methods and torque methods is explained by the suggestion of Anderson and Donovan (Abstr. 5902 of 1959).

D.J.Oliver

539.2 : 538.2

10120 INSTRINSIC AND ANNEAL-INDUCED ANISOTROPY IN COBALT-SUBSTITUTED W-TYPE HEXAGONAL OXIDES. L.R.Bickford, Jr.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 259S-260S (May, 1960).

The intrinsic and anneal-induced anisotropy of cobalt-substituted hexagonal ferrous W compounds containing some vacancies in lattice sites normally occupied by metal ions were measured by the torque method. Six oriented polycrystalline samples, corresponding to y = 0.03, 0.06, 0.12, 0.24, 0.45, and 0.9 in the formula $BaCo_yFe_{17.2-y}O_{27}$, and one single crystal of composition $Ba_{0.27}Sr_{0.73}Co_{1.948}Fe_{16.138}O_{27}$, were investigated. The results confirm the prediction that the cobalt ions and vacancies would be located in the spinel portion of the W lattice and therefore respond to magnetic annealing in much the same way as in the ferrite system Co_xFe_{3-x}. The contribution per cobalt ion to the anneal-induced anisotropy constant K_u was found to be approximately the same in the two systems ($\sim 3 \times 10^{-16}$ erg/cobalt ion for annealing at 100°C). Other points of comparison include the dependence on cobalt concentration of K_u and the relaxation times characterizing the annealing process, the activation energy and the variation of K_u with temperature of anneal. The first-order intrinsic hexagonal anisotropy constant K_1 becomes more negative with increasing cobalt concentration reaching a value of -4.35×10^6 erg/cm³ at 27°C for the single crystal. The value of K_3, the constant which determines the anisotropy in the basal plane, is much larger for this crystal than for any other hexagonal oxide reported so far ($K_3 = -1.22 \times 10^4$ erg/cm³ at 27°C and $+ 1.35 \times 10^5$ erg/cm³ at −196°C). Two of the compositions (y = 0.45 and 0.9) have cones of easy magnetization at −196°C.

539.2 : 538.2

10121 EXCHANGE ANISOTROPY IN Cu–Mn AND Ag–Mn ALLOYS. J.S.Kouvel.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 142S-147S (May, 1960).

Cu–Mn and Ag–Mn alloy specimens of about 25 atomic % Mn were cooled to 4.2°K in a magnetic field, and it was found that their hysteresis loops measured parallel to this field were displaced from their symmetrical positions about the origin. The displacement of the loops decreases monotonically with increasing temperature, and its disappearance is accompanied by large hysteresis losses. These unusual properties are similar to those previously reported for disordered Ni–Mn alloys and are also attributed to exchange anisotropy interactions between small regions of ferromagnetic and antiferromagnetic order. It is proposed that these regions arise from statistical composition fluctuations in the alloys and the existence of both ferromagnetic and antiferromagnetic interactions between Mn atoms. The essence of this microscopic exchange anisotropy model is illustrated for a square lattice representation of these alloys. The magnetic transformation temperatures are identified with anomalies in the $1/\chi$ versus T curves; these temperatures are considerably higher than those at which the exchange anisotropy effects disappear.

539.2 : 538.2

10122 ANGULAR VARIATION OF THE MAGNETIC PROPERTIES OF ELONGATED SINGLE DOMAIN IRON PARTICLES. F.E.Luborsky and T.O.Paine.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 66S-68S (May, 1960).

The demagnetization curves of oriented elongated single domain (ESD) iron particles have been measured as a function of angle and packing fraction. The reduced coercive forces of dilute compacts show a maximum at an angle of about 50° associated with a buckling magnetization reversal. As the packing fraction is increased, particle magnetostatic interaction lowers the coercive force and suppresses the 50° max. The residual to saturation ratio appears as a distorted cosine function, which the simple single domain particle model cannot account for without assuming particle orientations inconsistent with electron micrographs. A more realistic model is proposed which accounts for the experimental results by considering the effect on particle domain structure of dendritic branches and cross-links to adjacent particles. The new model has been analysed by measuring the magnetic properties of arrays of pivoted magnets, which simulate the proposed domain configurations at various angles and packing fractions.

539.2 : 538.2

10123 ROLL MAGNETIC ANISOTROPY OF IRON-ALUMINUM CRYSTALS. S.Chikazumi.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 158S-159S (May, 1960).

Magnetic anisotropy measurements and domain pattern observations were made on the rolled Fe_3Al single crystals. Rolling parallel to [001] on a (110) plane induced a uniaxial anisotropy as large as 7.1×10^5 erg cm^{-3} at 12% roll-reduction. The direction of easy magnetization was parallel to the roll direction. Calculations were made on the roll magnetic anisotropy in terms of the "slip-induced directional order model", under the assumption of (110) ⟨111⟩ slip system. (110) [1$\bar{1}$0], (001) [010], and (001) [110] rollings were also investigated.

539.2 : 538.2

10124 INFLUENCE OF IONIC ORDER ON THE MAGNETOCRYSTALLINE ANISOTROPY AND CRYSTALLINE FIELD PARAMETERS IN LITHIUM FERRITE MONOCRYSTALS.
V.J.Folen.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 166S-167S (May, 1960).

Measurements of the first order anisotropy constant (K_1), utilizing the torque method, are reported for various degrees of long range order (LRO) in lithium ferrite. The LRO parameters were determined by X-ray diffraction analysis. It is found that the degree of cation "order" in the octahedral sites strongly influences K_1. For example, measurements at 77°K yield the values -127×10^3 ergs cm^{-3} and -162×10^3 ergs cm^{-3} for K_1 in the "ordered" and "disordered" states, respectively. The experimental results were interpreted on the basis of the ferric ion spin Hamiltonian. Certain parameters (a_B' for octahedral sites and a_A' for tetrahedral sites) which include the contributions of the cubic term and the quartic axial term to cubic anisotropy were deduced from measurements of the temperature dependences of K_1 and saturation magnetization. It is found that in "disordered" lithium ferrite, $a_B' = +0.0242$ cm^{-1} and $a_A' = -0.0118$ cm^{-1}, in excellent agreement with the corresponding parameters determined by Folen and Rado in magnesium ferrite which is also a "disordered" ferrite. In the "ordered" lithium ferrite, it is found that $a_B' = +0.0104$ cm^{-1} and $a_A' = +0.0034$ cm^{-1}. The experimental temperature dependences of K_1 in both the "ordered" and "disordered" states are in quantitative agreement with that obtained from the Yosida-Tachiki theory. The changes in the magnitudes and signs of the observed a'-values resulting from the "order–disorder" transition are consistent with alterations of the quartic axial term.

539.2 : 538.2

10125 EXCHANGE ANISOTROPY IN THE SYSTEM $Mn_{(1-x)}Cr_xSb$. R.H.Pry, J.S.Kouvel and E.S.Miksch.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 162S-163S (May, 1960).

Magnetization and rotational hysteresis measurements have been made on some alloys of $Mn_{(1-x)}Cr_xSb$. For $0.5 \leq x \leq 0.7$ the rotational hysteresis continuously increases with applied magnetic field in the temperature range of 80-300°K. This behaviour supports the hypothesis that there is a coexistence of ferro- and antiferromagnetic components in this composition range and that there exists an exchange anisotropy due to the magnetic coupling between them. These magnetic components probably arise from local fluctuations in the Mn to Cr ratio caused by the near random distribution of these ions on the magnetic ion sites in this system.

539.2 : 538.2

10126 SINGLE-CRYSTAL MAGNETIC ANISOTROPY AND MAGNETOSTRICTION STUDIES IN IRON-BASE ALLOYS.
R.C.Hall.
J. appl. Phys., Vol. 31, No. 6, 1037-8 (June, 1960).

Single crystals of a number of binary iron-base alloys were grown, fabricated, and tested for magnetic anisotropy (K_1) and magnetostriction (λ_{100} and λ_{111}). The additions made to iron included

vanadium, molybdenum, germanium, chromium, titanium, and tin. The anisotropy of iron was lowered by the addition elements with the possible exception of tin. On the other hand, λ_{100} of iron was generally raised by these addition elements. Only titanium and tin lowered λ_{100}; however, titanium had limited solubility in iron and tin caused embrittlement.

539.2 : 538.2

10127 ANGLE-OF-INCIDENCE ANISOTROPY IN EVAPORATED NICKEL-IRON FILMS.

E.W.Pugh, E.L.Boyd and J.F.Freedman.

I.B.M. J. Res. Develop., Vol. 4, No. 2, 163-72 (April, 1960).

The magnetic anisotropies of iron, nickel, and permalloy films, evaporated onto glass substrates at various incident angles and substrate temperatures, have been measured by a torque method. For all compositions, the largest absolute value for the magnetic anisotropy occurs at the largest incident angle and lowest substrate temperature. A detailed calculation of the anisotropy resulting from a [111] fibre axis is found to fail to agree with the experimental results either in order of magnitude or in direction of the easy axis. The change in the magnetic anisotropies of films after removal from substrates is small enough that macroscopic stress cannot be the source of the anisotropy. A difference in electrical resistance parallel and perpendicular to a direction defined by the vapour stream during deposition is found to vary qualitatively very much like the magnetic anisotropy, both with film composition and incident angle. It is concluded that deposition at an angle of incidence produces an anisotropy in structural imperfections, which are interpreted in terms of shape and surface magnetic anisotropies as well as magnetostrictive effects.

539.2 : 538.2 : 550.3

EXCHANGE ANISOTROPY IN ROCK MAGNETISM.

See Abstr. 10388

539.2 : 538.2

10128 ON THE LAWS OF MAGNETIZATION OF FERROMAGNETIC SINGLE CRYSTALS AND POLYCRYSTALS. APPLICATION TO UNIAXIAL COMPOUNDS.

L.Néel, R.Pauthenet, G.Rimet and V.S.Giron.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 27S-29S (May, 1960).

The mechanism of magnetization of a ferromagnetic single crystal is described, the elementary domains being classified in several groups, called "phases" each having a certain direction of the spontaneous magnetization. The variation of the total magnetization takes place in various "modes", corresponding to the number of coexisting phases in a given field. The calculation of the magnetization curve in these various modes explains the experimental results for single crystals of iron, pyrrhotine and magnetoplumbite. The results of measurements at room temperature on this latter compound, $6Fe_2O_3 - PbO$, are treated in greater detail. The crystal is uniaxial; for different angles of the external field with the c axis, the magnetization first increases proportionally to the field, followed by a gradual approach to saturation (except for the angles 0 and 90°). The anisotropy constant K_1 is first determined (K_2 is negligible). The two parts of the curve can be interpreted by two "modes", with respectively, two and one "phases". The variation of the magnetization of polycrystalline $6Fe_2O_3 - BaO$ samples can be explained by the rotation mechanism only; the crystallites are too small in size to be divided into phases. The experimental curves can be explained by taking into account the interactions between crystallites in calculating the law of approach to saturation.

539.2 : 538.2 : 621.318.12

10129 FLUX REVERSAL IN SOFT FERROMAGNETICS.

E.M.Gyorgy.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 110S-117S (May, 1960).

Many aspects of flux reversal in soft ferromagnetic materials may be interpreted in terms of three types of flux reversal processes. These three types are domain wall motion, nonuniform rotation, and uniform rotation. It has been shown that in general wall motion is the predominant mechanism for values of the applied magnetic field slightly in excess of the coercive field, that nonuniform rotation predominates for intermediate magnetic fields, and that uniform rotation predominates for large fields. Thes salient features of these three types of flux reversal are discussed and compared with experimental findings. Special emphasis is given to polycrystalline, square-looped ferrites and thin Permalloy films. The importance of geometric effects is illustrated in a review of detailed models for the uniform and nonuniform rotational processes. Specific limitations of the existing models are discussed, and possibilities for future advances are briefly outlined.

539.2 : 538.2

10130 DIRECT-CURRENT MEASUREMENTS ON TAPE-WOUND CORES. R.C.Barker and R.M.Brownell.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 243S-244S (May, 1960).

This paper reports hysteresis-loop measurements made on tape-wound cores of commercial-grade grain-oriented 50Ni-50Fe material at very low domain wall velocities. The experimental equipment includes a low-output-impedance core driver, a low-drift electronic integrator, and a 30 in. × 30 in. X-Y recorder. The duration of a complete flux reversal can be varied between 5 seconds and 30 minutes. The rate-of-change of flux during a reversal can be held constant within 1%, so that variations in the ease of domain wall motion (which appear as Barkhausen discontinuities in conventional measurements) are constrained to appear as variations of magnetomotive force. The coarse structure of these variations is repeatable on successive measurements; the fine structure, for the most part, is not. In addition to showing these variations of m.m.f., the experimental arrangement displays minor loops in their correct locations with respect to the major loop. These measurements indicate that, under d.c. conditions, flux changes always begin at the inner circumference of the core, as predicted by a previously proposed model of flux change in polycrystalline tapes. On the basis of the model, the recorded variations in m.m.f. can easily be used to find the variations in the energy required to move domain walls in various portions of the core, under conditions of constant rate-of-change of flux. (Under such conditions, the product of wall velocity and wall area is a constant.) The repeatability of the coarse variations indicates their dependence on local metallurgical variations within the core. The nonrepeatability of the fine variations probably indicates a randomness in the configuration of the domain walls as they pass through the same region on successive measurements.

539.2 : 538.2

10131 STUDY OF HEAT TREATMENTS FOR LOW COERCIVE FORCE 14 TO 17% ALUMINIUM IRON ALLOYS.

D.Pavlovic and K.Foster.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 231S-232S (May, 1960).

A study was made of the effects of atmosphere, temperature of initial annealing, and composition on the coercive force of 14 to 17% Al—Fe alloys. A combined effect of heat treatment atmosphere and temperature of initial annealing is shown to exist in this alloy region and is discussed in terms of a possible influence of purification and atomic ordering. The unique feature of these alloys is that heat treatments in air at 900°C produce lower coercive force values than heat treatments in dry hydrogen at the same temperature. This factor would make the heat treatments of these alloys more economical than those of other standard high-permeability alloys. Observations made on the binary Al—Fe iron alloys apply to the heat treatment of Al—Fe alloys containing ternary additions. These observations also show that the heat treatment controls both the grain size and the distribution of the second phase in ternary alloys, which in turn affect the magnetic properties.

539.2 : 538.2

10132 THE STUDY OF MAGNETIC VISCOSITY IN CARBON STEELS AS A FUNCTION OF FATIGUE.

G.Iliescu, D.Bărbulescu, G.Savin and V.Petrescu.

Bul. Inst. Politeh. Iasi, Vol. 4 (8), No. 3-4, 259-62 (1958).

In Roumanian.

The test sample, subjected to 2×10^6 cycles of torsional stress between each measurement, is compared in a test rig against an identical, non-fatigued, sample. At a certain value of the coercive field, magnetic viscosity effects are a maximum and amplitude measurements of this effect are taken 3 seconds after cessation of the magnetizing field. It is concluded that viscosity effects increase with fatigue, especially with harder steels. 6 references.

A.Reiss

539.2 : 538.2 : 539.3

INTERNAL FRICTION ANOMALIES IN FERROMAGNETS AND ANTIFERROMAGNETS NEAR THE CURIE POINT. See Abstr. 10256.

539.2 : 538.2

10133 COERCIVE FORCE AND REMANENCE OF 25-A TO 2000-A DIAMETER COBALT, IRON, AND IRON-COBALT ALLOY. F.E.Luborsky and T.O.Paine.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 68S-70S (May, 1960).

This paper reports an experimental study of the size dependence of the coercive force and remanence of essentially spherical cobalt, iron, and iron-cobalt alloy particles over the diameter range from 25A to 2000 A. The particles were prepared by low-temperature electrodeposition into a mercury capillary jet, followed by thermal growth; size and shape distributions were determined by electron microscopy. The maximum coercive force at 76°K was 1330 Oe for cobalt, 890 Oe for iron, and 1380 Oe for iron-cobalt alloy; these maxima occurred at a diameter of 30 A for cobalt, 130 A for iron, and 240 A for iron-cobalt alloy. At a sufficiently small diameter superparamagnetism reduced the remanence and coercive force to zero. This occurred at a particle diameter below 25 A for cobalt, at 50 A for iron, and at 40 A for iron-cobalt alloy. The coercive force, remanence, and their temperature coefficients are discussed in terms of the approach to single domain behaviour, the anisotropy constants which determine single domain rotation, and the transition to superparamagnetic behaviour. Crystal anisotropy predominates in the cobalt particles, a combination of shape and crystal in the iron particles, and shape anisotropy in the iron-cobalt alloy particles.

539.2 : 538.2

10134 VARIATION OF MAGNETIC MOMENT WITH COMPOSITION IN THE IRON–VANADIUM SIGMA PHASE.
D.Parsons.
Nature (London), Vol. 185, 839-40 (March 19, 1960).

Results are given for the spontaneous magnetization as a function of temperature of sigma-phase iron–vanadium alloys in the composition range from 42 to 50% V. The Curie points were found to be lower than those of α-phase alloys of the same composition. A linear extrapolation of the low temperature spontaneous magnetization indicates zero moment for 53% V, although the composition limit of the sigma phase is at 57% V. The results might be explained in terms of either a redistribution with composition of positive and negative spins in a common d band or a composition-sensitive ferrimagnetic arrangement of the spins. R.Parker

539.2 : 538.2

10135 NEW MATERIAL FOR PERMANENT MAGNETS ON A BASE OF Mn AND Al.
A.J.J.Koch, P.Hokkeling, M.G.v.d.Steeg and K.J.de Vos.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 75S-77S (May, 1960).

During an investigation of the Mn-Al system from 40-100% Mn, a new metastable phase was found, which has a tetragonal structure with lattice constants a = 2.77 A and c = 3.57 A and lattice positions 000 and $\frac{1}{2}\frac{1}{2}\frac{1}{2}$ with a preference of the Mn atoms for one of these positions. This τ phase, which has the approximate composition $Mn_{1.11}Al_{0.89}$, can only be obtained by special heat treatment. It possesses remarkable magnetic properties. From the approach to saturation an anisotropy constant of about 10^7 ergs/cm^3 can be calculated, while the extrapolated value σ_∞ amounts to 96 erg/Oe g; the latter corresponds to a $4\pi I_s$ of 6200 G. Particles obtained by grinding the bulk material possess an $_iH_c$ value of up to 6000 Oe. No fixed correlation exists between particle size and the value of $_iH_c$; the latter is strongly dependent on the method of pulverization, and the authors are inclined th think that $_iH_c$ is largely determined by the extent of deformation. The increase of $_iH_c$ caused by grinding is accompanied by a decrease of the magnetic moment. This decrease can be partially reversed by ageing. The observed decrease in the magnetic moment on pulverizing agrees with the value calculated from X-ray and neutron diffraction data. The current fine-particle theory is unable to give an adequate explanation of the $_iH_c$. An anisotropic permanent magnet was obtained by swaging cast bars, with the following properties in the preferred direction: B_r = 4280G, $_iH_c$ = 4600 Oe, $_BH_c$ = 2750 Oe, BH_{max} = 3.5 × 10^6 G Oe.

539.2 : 538.2

10136 SAMARIUM SUBSTITUTIONS IN YTTRIUM IRON GARNET.
J.R.Cunningham, Jr and E.A.Anderson.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 45S-48S (May, 1960).

Polycrystalline garnets of the form $(3-x)Y_2O_3.xSm_2O_3.5Fe_2O_3$ have been prepared where x was varied from 0 to 3 in six steps. Lattice constants were found to vary linearly from 12.374 ± 0.005 A for YFe garnet (x = 0) to 12.533 ± 0.005 A for SmFe garnet (x = 3). The theoretical x-ray densities were calculated and vary from 517 g/cm^3 for x = 0 to 6.22 g/cm^3 for x = 3. Magnetic moments were measured from 77° to 600°K. No magnetic compensation points were observed. The Curie temperature for these garnets is 570 ± 10°K. Thermal magnetization curves for this series indicate that Sm substitution for Y produces very little change in the magnetization. The relative complex initial permeability was measured from d.c. to 2 kMc/s for several temperatures. The results of these measurements are discussed briefly.

539.2 : 538.2

10137 INITIAL PERMEABILITY CHARACTERISTICS OF MIXED YTTRIUM-GADOLINIUM IRON GARNETS.
G.E.McDuffie, Jr , J.R.Cunningham, Jr and E.E.Anderson.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 47S-48S (May, 1960).

Complex initial permeability measurements have been made on polycrystalline garnet toroids of the form $(3-x)Y_2O_3.xGd_2O_3.5Fe_2O_3$ where x ranged from 0 to 3. Both the real (μ') and the imaginary (μ'') initial permeabilities were measured at 23° - 78° and -196°C over a frequency range of 1 kc/s to 2000 Mc/s. At room temperature, the low-frequency value of μ' was found to decrease with increasing gadolinium content, and at lower temperatures exhibits a minimum in x caused by the temperature dependent behaviour of the two different magnetic sublattices. The frequency at which the maximum value of μ'' occurs was found to increase with the addition of gadolinium. No thermal relaxation was observed in these garnets, but rather the peaks in the curves shifted to slightly higher frequencies with decreasing temperature.

539.2 : 538.2

10138 THE REASONS FOR THE DEVELOPMENT OF A TRANSVERSE TEMPERATURE DIFFERENCE IN A FERROMAGNETIC CARRYING A LONGITUDINAL THERMAL CURRENT. N.P.Patrakhin.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 5, 666-8 (1959).
In Russian.

The mathematical theory of the Righi–Leduc effect in ferromagnetics is given on the s-d exchange model. The effect of the internal field of a ferromagnetic is the same as in galvanomagnetic (Hall) and the other thermo-magnetic (Nernst–Ettinghausen) effects. See Abstr. 9776 of 1959. A.F.Brown

539.2 : 538.2

10139 ON THE THERMOMAGNETIC EFFECTS OF MONOVALENT METALS. A.K.Rajagopal.
Proc. Phys. Soc., Vol. 75, Pt 3, 463-4 (March, 1960).

Jones (Abstr. 3755 of 1956) explained the positive thermoelectric power of noble metals as being due to the Fermi surface lying very close to the Brillouin zone boundaries. The same circumstance accounts for the positive values of the Nernst and Ettingshausen coefficients in copper and other metals. L.Pincherle

539.2 : 538.2

10140 ON THE THEORY OF THE TEMPERATURE DEPENDENCE OF THE MAGNETIZATION OF AN IDEAL FERROMAGNET AT LOW TEMPERATURES. W.Opechowski.
Physica, Vol. 24, Supplement, S179 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A slightly improved version of Kramer's approximate method of calculating the partition function of an ideal ferromagnetic substance at low temperatures is compared with Dyson's method (Abstr. 5998-9 of 1956) of calculating the same quantity. In particular, it is shown under which conditions Kramers' method leads to Dyson's expression for the magnetization in the case of spin $\frac{1}{2}$. A possible justification of these conditions is discussed.

539.2 : 538.2

10141 ON THE RESOLUTION OF BROWN'S PARADOX.
S.Shtrikman and D.Treves.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 72S-74S (May, 1960).

The possibility is examined that Brown's paradox (see Abstr. 524 of 1946) results from the assumption that the shape of the crystal considered is ellipsoidal. It is argued that the large local demagnetizing fields developed near sharp corners of a uniformly magnetized crystal cause the appearance of closure domains, which serve as nuclei of reverse magnetization, thus lowering the coercive force. A tentative development of these domains upon the application of a reverse field is given.

539.2 : 538.2

10142 INTERNAL STRUCTURE OF BLOCH WALLS.
S.Shtrikman and D.Treves.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 147S-148S (May, 1960).

The subdivision of a Bloch wall into a periodic structure of

right and left hand walls observed by Williams and Goertz and by DeBlois and Graham is shown to be caused by the self-magnetostatic energy of the wall. The period of this structure is calculated by an approximate minimization of the energies involved. The results compare favourably with experimental evidence.

539.2 : 538.2

10143 RIGOROUS SOLUTION OF EDDY CURRENT LOSSES IN RECTANGULAR BAR FOR SINGLE PLANE DOMAIN WALL MODEL. P.D.Agarwal.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 246S-248S (May, 1960).

Williams, Shockley, and Kittel, and other authors have presented a simple domain model in which magnetization takes place by the movement of a single plane domain wall. The net flux is zero when the domain wall is in the middle of the cross-section and the material is magnetized fully when the wall moves to the surface. Maxwell's equations for the case of a rectangular bar are rigorously solved for any position of the wall and expressions are derived for the current stream function in both regions I and II. The stream function was calculated using an IBM 705 computer and is shown for various positions of the wall and for several ratios of the sides of the rectangle. The power loss for sinusoidal applied induction is calculated. The results show that the loss in the material increases as the distance traversed by the wall, i.e., the dimension of the rectangle at right angles to the domain wall increases. This solution with some modification also applies to thin laminations; where the domain model, proposed by several authors, consists of domains of equal width alternately magnetized in opposite directions to give the unmagnetized state. The domain walls are perpendicular to the plane of the sheet and magnetization in the sheet plane takes place by lateral movement of these domain walls. For any given thickness of the laminations, a domain wall spacing can be determined to correlate the power loss with experimental values.

539.2 : 538.2

10144 EFFECT OF EDDY CURRENTS ON DOMAIN WALL BEHAVIOR CONFIGURATIONS, WALL MOTION, AND LOSS FOR A DOMAIN MODEL OF CUBE-ON-EDGE MATERIAL. P.D.Agarwal and D.C.Graham.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 249S-250S (May, 1960).

Domain wall motion in single crystals and polycrystalline material has been observed and studied by many physicists and metallurgists under different conditions of excitation. The field has been applied in the rolling direction and in the cross rolling direction and observations made on the surface of the domain wall motion. In these studies the rate of change of wall motion of necessity must be slow because of the limitations of the procedure for following and photographing the wall motion. It has been recognized that at higher frequencies, the wall tends to bow, but the actual motion has not been defined. The published data under d.c.excitation conditions, along with the required minimum energy relationship, establishes the domain model has been developed which appears to fit these boundary conditions under d.c. excitation. Analysis of the induced voltage and resulting eddy currents was made on the assumption that the domain wall remain straight and that the velocity was such as to give sinusoidal flux change. The actual flow of eddy currents dictated that the wall must bow. By modifying the domain wall motion to fit the conditions as dictated by the eddy currents, the eddy current losses were calculated and compared with losses measured in present-day material. The variations of magnetizing force with time are also calculated and show reasonable agreement with expected excitation curves versus time.

539.2 : 538.2

10145 MAGNETIZATION PROCESS IN FERROMAGNETS. L.V.Kirenskii, M.K.Savchenko and I.F.Degtyarev.
Zh. eksper. teor. Fiz., Vol. 37, No. 3 (9), 616-19 (Sept., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37 (10), No. 3, 437-41 (March, 1960).

The dynamics of the domain structure during magnetization were studied in crystals of silicon iron containing 3% silicon, using the powder figure method and the magneto-optical Kerr effect. It is shown that magnetization is achieved in the general case by the following processes: displacement of the domain walls, rearrangement of the domain structure, rotation of the magnetization vector in the direction of the field, and the paraprocess. The rotation process terminates technical magnetization; the process of boundary displacement precedes the rearrangement of the domain structure and completes it.

539.2 : 538.2

10146 THE SURFACE STRUCTURE OF CLOSURE DOMAINS IN THE (100) PLANES IN IRON. L.Špaček.
Czech. J. Phys., Vol. 7, No. 6, 714-22 (1957). In German.

The "tree" appearance of the closure domains in planes slightly inclined to the (100) planes is explained from energy considerations and the dependence of the size of the regions on the angle of inclination of the plane to the (100) planes is obtained by minimizing the total energy. J.E.Caffyn

539.2 : 538.2

10147 NOTE ON A PAPER BY L.ŠPAČEK ENTITLED "THE SURFACE STRUCTURE OF CLOSURE DOMAINS IN THE (100) PLANES IN IRON". J.Kaczér and R.Gemperle.
Czech. J. Phys., Vol. 9, No. 3, 413 (1959). In German.

An error in the calculation of the energy is pointed out. J.E.Caffyn

539.2 : 538.2

10148 CORRECTION TO THE PAPER ENTITLED "THE SURFACE STRUCTURE OF CLOSURE DOMAINS IN THE (100) PLANES IN IRON". L.Špaček.
Czech. J. Phys., Vol. 9, No. 3, 414 (1959). In German.

539.2 : 538.2

10149 COMPARISON OF THE CRITICAL SINGLE DOMAIN SIZE FOR Fe_3O_4 AND γ-Fe_2O_3. L.A.K.Watt and A.H.Morrish.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 71S-72S (May, 1960).

On theoretical grounds the critical single domain size for γ-Fe_2O_3 is expected to be somewhat larger than for Fe_3O_4. Measurements of the variation of coercive force with temperature and with compression for a single iron-oxide powder in both the Fe_3O_4 and γ-Fe_2O_3 forms yield strong evidence in support of this conclusion.

539.2 : 538.2

10150 THE ELEMENTARY DOMAINS IN A SINGLE CRYSTAL OF MAGNETOPLUMBITE ($6Fe_2O_3$. PbO). M.Paulus.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2332-4 (March 28, 1960).
In French.

Magnetoplumbite forms a hexagonal crystal with a single easy axis of magnetization parallel to the hexagonal axis. A series of photographs shows the domain patterns observed on the basal plane both with and without an applied field. D.J.Oliver

539.2 : 538.2

10151 THE DOMAIN STRUCTURE OF MAGNETOPLUMBITE. L.F.Bates, D.J.Craik, P.M.Griffiths and E.D.Isaac.
Proc. Roy. Soc. A, Vol. 253, 1-5 (Nov. 17, 1959).

The domain structure of crystals of $PbO(Fe_2O_3)_6$ is described and is shown to behave in an unusual manner as the crystals are magnetized to saturation. Electron micrographs of the interaction of domain walls with inclusions and details of the basal plane pattern are given.

539.2 : 538.2

10152 DOMAIN WALLS IN THIN Ni–Fe FILMS. S.Methfessel, S.Middelhoek and H.Thomas.
I.B.M. J. Res. Developm., Vol. 4, No. 2, 96-106 (April, 1960).

Observations of domain walls in Ni–Fe films as a function of thickness demonstrate the strong influence of magnetic stray fields on the wall structure, hence on the coercivity for wall motion. In order to reduce the stray-field energy, the Bloch walls in films thicker than 1000 A are subdivided into sections with alternating polarity which are separated by Bloch lines. In thinner films, the domain walls are of the Néel type. The position of Bloch lines in such walls is indicated by crosswalls. The motion of Bloch lines in an applied field can be observed particularly easily on scratches in negative magnetostrictive material; such scratches display properties corresponding to Néel walls. Crosswalls are also present at the ends of domains and around holes in the film material. A crosswall is distinguished from ordinary domain walls by the continuous change of the angle of magnetization along both sides of it.

539.2 : 538.2

10153 "SPONTANEOUS MAGNETIC ANISOTROPY" IN POLYCRYSTALLINE THIN FILMS. W.Andrä, Z.Málek, W.Schuppel and O.Stemme.
J. appl. Phys., Vol. 31, No. 2, 442-3 (Feb., 1960).

Evidence has been obtained to show that the anisotropy in ferromagnetic films produced in a magnetic field is not caused immediately by the external field but by spontaneous magnetization in the film. Geometrical anisotropy appears to be excluded since the magnetic anisotropy is found in films rotated during production and also by changes in anisotropy which can be produced by ageing in a magnetic field. The results may be explained by the formation of an easy axis in direction of spontaneous magnetization in each domain during and after film production. It is suggested that the underlying cause may be some substructure orientation influenced by the spontaneous magnetization. F.E.Hoare

539.2 : 538.2

10154 THE REMANENCE OF FERROMAGNETIC POWDERS. S.Shtrikman and D.Treves.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 58S-66S (May, 1960).

The angular dependence of the maximum remanence parallel to the applied field, I_p, and perpendicular to it, I_t, when the specimen is rotated through an angle β about an axis perpendicular to the field direction, is considered theoretically. For a rather wide range of materials the relation $I_t = (dI_p/d\beta)$ should hold. For an assembly of noninteracting uniaxial single domains, it is shown that the distribution of the easy axes can be calculated from $I_p(\beta)$ or $I_t(\beta)$ and that $2\int_0^{\pi/2} I_p \sin\beta d\beta = I_s$, where I_s is the saturation magnetization. The above method yields a Legendre series for the distribution; it is deficient in that the high terms are quite sensitive to small changes in the remanences. Measurements of I_p and I_t with a vibrating-sample magnetometer were carried out on commercially oriented Ferroxdure, on magnetically oriented Ferroxdure powder, on oriented elongated single domain iron particles and on anisotropic Alnico. For the first three materials I_t was a few percent lower, for the last up to 20% higher, than the value theoretically expected from the relation between I_p and I_t. For Ferroxdure this small discrepancy is attributed to the reduction of I_t by splitting into domains; for the elongated single domain sample it is attributed to particle agglomeration. In order to furnish further magnetic evidence for the agglomeration of particles in magnetic powders, remanence curves are considered. Relations between remanences obtained by different methods are derived for the interacting-pair model. These relations differ from Wohlfarth's relations, which hold for an assembly of noninteracting single domain particles. Comparison with experiment favours the pair model.

539.2 : 538.2

10155 PRECIPITATION OF DISPERSED FINE-PARTICLE MAGNETITE. L.E.Slaten.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 74S-75S (May, 1960).

A method has been developed for preparing well-dispersed fine-particle magnetite by precipitation in situ. A solution of Fe^{++} and Fe^{+++} is formed into a sol by the addition of agar-agar and polyvinyl alcohol; magnetite particles are then precipitated by diffusing NaOH into the resulting semi-rigid gel. The size range of these particles is from 40 A to 800 A. Typical magnetite films exhibit a coercivity of about 50 Oe, with a B_r/B_s ratio of 0.4. A study of the precipitation reaction has shown that the properties of the resulting magnetic particles appear to be limited by factors intrinsic in the mechanism of the reaction rather than by the limitations imposed by the gel-resin system used.

539.2 : 538.2

10156 FERROMAGNETIC POWDERS IN WAVEGUIDES AT ELEVATED TEMPERATURES.

A.D Krall and E.T.Hooper, Jr.

J. appl. Phys., Suppl. to Vol.31, No. 5, 178S (May, 1960).

Brief note, substantially as follows. A preliminary investigation has been made of the temperature effects of powdered ferromagnetic metals at microwave frequencies. No external magnetic fields are applied. Distinct changes in the v.s.w.r. and minimum position occur at the temperatures for known Curie points, phase changes and zero anisotropy. Powder metallurgy changes such as sintering and outgassing have been observed. The simplicity of equipment necessary to reach extremely high temperatures should provide a valuable tool in studying and understanding changes occuring in high temperature alloy systems.

539.2 : 538.2

10157 NANOSECOND SWITCHING IN THIN MAGNETIC FILMS. W.Dietrich, W.E.Proebster and P.Wolf.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 189-96 (April, 1960).

A special pulse equipment including a pulse-sampling oscilloscope with an over-all response time of 0.35 nanosecond (10^{-9} sec) for the observation of the nanosecond flux change in thin permalloy films is described. Film switching signals as short as 1 nanosecond have been obtained and are discussed with respect to the underlying processes. Inverse switching time versus driving-field curves have been plotted for films of different thicknesses. They show that thinner films switch faster than thicker ones. The slopes of these curves have characteristic values in the nanosecond region of about 10^3 per oersted-second. Coherent rotation and oscillation of the magnetization have been clearly detected by picking up the flux change transverse to the driving field.

539.2 : 538.2

10158 TRANSMISSION ELECTRON DIFFRACTION OF ALNICO V. K.J.Kronenberg.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 80S-82S (May, 1960).

By grinding, polishing, and etching it is possible to render Alnico V thin enough for transmission electron metallography. 80 kV electrons penetrated Alnico V metal confirming the two-phase structure found earlier with replica techniques. Transmission diffraction on Alnico V samples reveal the crystal structures of both phases. The development of one phase out of the other was studied on samples from Alnico V at various states of the usual heat treatment.

539.2 : 538.2

10159 THE TEMPERATURE DEPENDENCE OF THE SATURATION MAGNETIZATION OF NICKEL FILMS OF THICKNESS LESS THAN 100A. C.A.Neugebauer.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 152S-153S (May, 1960).

Nickel films varying in thickness from 300 to 15 A were prepared by evaporation on glass substrates in a vacuum sufficiently high to prevent gas adsorption on the film during preparation and measurement. Their magnetization was measured as a function of field up to 10 000 Oe using a vacuum torsion magnetometer. The saturation magnetization of these films was determined as a function of their thickness at various temperatures. No decrease in saturation magnetization from that of bulk nickel has been observed for films of thickness down to 20 A, at room temperature. The Curie temperature of a 30 A film was found to coincide with that of bulk nickel.

539.2 : 538.2

10160 INITIAL SUSCEPTIBILITY SPECTRA OF PERMALLOY FILMS. R.F.Soohoo.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 218S-219S (May, 1960).

The initial susceptibility of Permalloy films from 100 to 10 000 Mc/s is investigated theoretically and experimentally. The exact boundary value problem of a film placed in a rectangular cavity is solved. This result is compared with the simpler solution obtained by means of the Bethe–Schwinger perturbation formula. As may be expected, the exact solution reduces to that obtained from perturbation theory when the film thickness and the value of the initial susceptibility are sufficiently small. In a self-consistent way, it is shown that exchange effects can sometimes be neglected as far as initial susceptibility values are concerned.

539.2 : 538.2

10161 THE DIRECTION DEPENDENCE OF MAGNETOSTRICTION. W.Döring and G.Simon.

Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 7-8, 373-87 (1960). In German.

Magnetostriction is described by means of a symmetrical tensor whose components depend on the direction of magnetization. This dependence is evaluated group theoretically for all crystal symmetries. E.P.Wohlfarth

539.2 : 538.2

10162 THEORY OF THE TEMPERATURE DEPENDENCE OF THE MAGNETOELASTIC CONSTANTS OF CUBIC CRYSTALS. C.Kittel and J.H.Van Vleck.

Phys. Rev., Vol. 118, No. 5, 1231-2 (June 1, 1960)

The conventional theory of the variation with temperature of the anisotropy of cubic crystals is extended to include the magnetoelastic constants.

539.2 : 538.2

10163 COUPLED MAGNETO-ELASTIC OSCILLATIONS IN ANTIFERROMAGNETICS. S.V.Peletminskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 452-57 (Aug., 1959). In Russian. English translation in : Soviet Physics – JETP (New York), Vol. 37(10), No. 2, 321-4 (Feb., 1960).

A phenomenological theory is given (the coupling between elastic and magnetic waves is due to magnetostriction and spontaneous magnetization). The velocities of sound in the antiferromagnetic are determined; they are found to depend on the magnetization and the applied magnetic field. The acoustic absorption coefficient is found.

539.2 : 538.2

10164 ON THE MAGNETOSTRICTION OF GADOLINIUM IRON GARNETS. K.P.Belov and A.V.Pedko.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 55S-57S (May, 1960).

The temperature dependence of magnetostriction in the gadolinium ferrite having structure of a garnet has been measured within the temperature range from liquid nitrogen up to the Curie point. At temperatures above the compensation point of sublattices (θ_k), the magnetostriction isotherms are of the same kind as for ferromagnetics ($\lambda_{\parallel}$ and $\lambda_{\perp}$ have opposite signs and the λ versus H curves exhibit saturation). In cooling below θ_k there is an effect of superposition of large volume magnetostriction of paraprocess on the "ordinary" magnetostriction, which results in the distortion of the magnetostriction isotherms ($\lambda_{\parallel}$ and $\lambda_{\perp}$ are of the same sign and without saturation). It is shown that the "ordinary" magnetostriction is caused by the interaction of Fe^{3+} ions in sublattices a and d, while the volume magnetostriction of the paraprocess is caused by the interaction of Gd^{3+} and Fe^{3+} ions.

539.2 : 538.2

10165 MAGNETIC CONTRIBUTION TO THE ULTRASONIC ATTENUATION IN ANNEALED AND DEFORMED STEEL (SAE 1020).

W.J.Bratina, U.M.Martius and D.Mills.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 241S-242S (May, 1960).

The absorption of ultrasound of ~3 Mc/s frequency was investigated in low carbon steel as a function of elastic strain applied in the presence of constant magnetic fields. The observed attenuation changes are interpreted in terms of magnetomechanical damping. The major part of the change appears to be accounted for by variation in the amplitude of the domain wall vibration, while the domain configuration changes appear to have relatively small effect. The maximum observed in the attenuation-strain curve for plastically deformed material is attributed to the presence of internal stresses.

539.2 : 538.2

10166 EFFECTS OF HYDROSTATIC PRESSURE ON THE PROPERTIES OF MAGNETIC MATERIALS.

R.E.Alley, Jr and V.E.Legg.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 239S-240S (May, 1960).

A review of the literature on hydrostatic pressure effects on magnetic materials showed a lack of information on technologically important properties such as initial permeability, and the hysteresis loop. Measurements of these properties up to 20 000 lb/in^2 showed that most solid materials are only slightly affected. These include tape cores of supermalloy, supermendur, 4-79 Mo-permalloy and grain-oriented Si-steel, as well as S-5 ferrite memory cores, and compressed powder cores of 2-81 Mo-permalloy or of carbonyl iron. Some types of NiZn and MnZn ferrite show increase of coercive force and decrease of permeability with pressure. Measurements were made of permeability versus frequency of MnZn ferrite to find the relaxation frequency. At atmospheric pressure, the permeability shows a sharp decline above 0.85 Mc/s . At 20 000 lb/in^2 the decline in permeability does not occur until 1.6 Mc/s.

539.2 : 538.2

10167 THE EFFECTS OF DIRECTIONAL ORDERING ON THE DAMPING OF ZONE-MELTED IRON. R.E.Maringer.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 229S-230S (May, 1960).

Damping measurements (1-2 c/s) have been made as a function of temperature and time on zone-melted high-purity iron, to which carbon or nitrogen have been added. Measurements were made with and without a magnetic field to isolate the magnetoelastic contribution to the damping. Two principal effects exist. These are a distortion of the Snoek peak and a time-dependent decrease in damping, which has been called the "magnetoelastic aftereffect". Magnetoelastic after-effect data for zone-melted iron, containing carbon, have been analysed and shown to yield relaxation times in good agreement with those expected on the assumption that the effect is controlled by the interstitial diffusion of carbon.

539.2 : 538.2

10168 EFFECT OF APPLYING A MAGNETIC FIELD DURING NEUTRON IRRADIATION ON THE MAGNETIC PROPERTIES OF Fe-Ni ALLOYS. A.I.Schindler and E.I.Salkovitz.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 245S-246S (May, 1960).

To test the similarity between thermally induced ordering and irradiation induced ordering, a series of commercial Fe-Ni samples have been irradiated in the presence of a saturating magnetic field. Square hysteresis loops were found for all the samples irradiated in this manner. Such results are consistent with the proposal that directional short range ordering and consequent uniaxial anisotropy has been created by the neutron irradiation.

539.2 : 538.2 : 621.374.32 : 621.318.12

10169 A NEW APPROACH TO HIGH-SPEED STORAGE–LOW FLUX DENSITY MATERIALS.

W.L.Shevel, Jr. and H.Chang.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 125S-126S (May, 1960).

Presents a new approach toward overcoming the factors currently limiting the frequencies at which storage devices may be switched from one information state to another. Ferrite elements for random access storage have been developed which require a fraction of a microsecond for a cycle. Thus the ferrite switching time establishes a maximum switching rate given by the inverse of the total switching time in a cycle. However, operation of elements such as these in a large capacity memory at rates limited only by switching times is usually prevented by: deterioration of magnetic properties due to heating effects, increase in selection line impedance, and long transmission delays. A series of ferrimagnetic oxides have been developed with properties such that the limits on minimum cycle time are appreciably extended. The most important of these properties is the saturation flux density. Over a range of composition, flux densities have been obtained which extend from 100-500 G. The lower flux density results in an appreciably lower energy dissipation in the magnetic structure and consequently in higher switching rates for a given temperature rise within the magnetic material. In addition, temperature dependence of those magnetic properties which determine storage applicability is more favourable than with the better known ferrites. Toroids have been fabricated with these materials which are suitable for random access memories. These elements have been operated successfully in free air at repetition frequencies in excess of 2 Mc/s. The improvements in array characteristics that result are discussed in terms of impedances and transmission delays.

539.2 : 538.2

10170 NONRESONANCE ABSORPTION OF THE ENERGY OF AN ALTERNATING MAGNETIC FIELD BY A FERROMAGNETIC DIELECTRIC. M.I.Kaganov and V.M.Tsukernik.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 823-32 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 587-92 (March, 1960).

Spin-waves theory is used to calculate the imaginary part of the longitudinal magnetic susceptibility.

539.2 : 538.2

10171 MEASUREMENT OF THE COMPLEX DIELECTRIC SUSCEPTIBILITY AND THE MAGNETIC SUSCEPTIBILITY TENSOR OF FERRITES IN THE MILLIMETRE REGION.

D.I.Mash and V.V.Nikol'skii.

Zh. tekh. Fiz., Vol. 29, No. 9, 1070-3 (Sept., 1959). In Russian. English translation in: Soviet Physics – Technical Physics (New York), Vol. 4, No. 9, 978-80 (March, 1960).

An apparatus employing the cavity resonator technique to measure the susceptibilities of ferrite specimens at 8.0 mm wavelength is described. Results of susceptibility measurements on specimens of ferrites (type B, type NTS-500 and type F-600, the compositions of which are not mentioned) in different orientations of the steady magnetic field are described. The field dependence of the components of the magnetic susceptibility tensor are in agreement with theory, and with lower frequency measurements.

S.A.Ahern

539.2 : 538.2 : 621.318.1 : 621.374.32

10172 FAST SWITCHING BY DOMAIN WALLS IN FERRITES. W.Wiechec and C.M.Kelley.

J. appl. Phys., Suppl to Vol. 31, No. 5, 131S-132S (May, 1960).

Experimental evidence indicates that small grain size is associated with faster domain wall switching in ferrite cores. It has been shown by Amar (Abstr. 224 of 1958) that small grain size contributed an additional energy to the wall energy density σ_ω. Incorporation of this energy into the power equation $H(dM/dt) = \lambda H_e^2$ reveals that the loss coefficient decreases more than σ_ω increases,

and, therefore, faster switching results. A qualitative explanation is given for faster switching by domain walls in magnetic materials. The significant variables in the switching coefficient equation are "d", T_C, K and σ. Experimental data show that the switching coefficient is lowered by decreasing values of the first three variables. Considerably faster switching is predicted when similar cores with grain sizes less than one micron are made.

539.2 : 538.2 : 621.374.32

10173 EFFECT OF PREVIOUS HISTORY ON SWITCHING RATE IN FERRITES. R.W.McKay and K.C.Smith.

J. appl. Phys., Suppl to Vol. 31, No. 5, 133S-134S (May, 1960).

Existing theories of switching of square-loop ferrites indicate that the rate of switching is a function of the present state of magnetization and of the applied field. Experiments are described which show that the switching rate is also dependent on previous history. Two cases have been studied. In the first case, the ferrite was partially switched to a predetermined extent by a pulse of variable amplitude and then the switching cycle was completed by a pulse of fixed amplitude. In the second, the ferrite was brought to the remanent state by a pulse of variable amplitude before the switching cycle. Changes as great as two to one in switching rate were produced by variations of previous treatment.

539.2 : 538.2

10174 THE ROLE OF CATION VACANCY IN MAGNETIC ANNEALING OF IRON–COBALT FERRITES. S.Iida.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 251S-258S (May, 1960).

The kinetics of magnetic annealing effects in iron–cobalt ferrites is studied, based on a vacancy migration mechanism. First, a formal theory is developed, which makes clear the existence of a distribution of relaxation times in the phenomena. In order to get the distribution function of the relaxation time as a function of vacancy concentration and diffusion constants, a calculation based on a rather stochastic approach has been given. It is assumed that the dispersion in the relaxation time comes principally from the time required for the vacancies to migrate throughout the entire crystal lattice. The distribution function obtained is $f(\tau) = W\rho\tau/\tau_0 \times \exp(-W\rho\tau/\tau_0)$, where ρ is the density of vacancies, τ_0 is the mean relaxation time for the migration of a single vacancy, and W is a constant which depends on the lattice type, degree of short range ordering, and so on. On using this function the formation and the annihilation of the degree of directionality S_u is expressed as

$$\Delta S_u = \int_0^\infty f(\tau)\Delta S(\tau)d(\log\tau),\ \Delta S(\tau) = [S(\tau) - S^*(T)](-\Delta t/\tau_0).$$

A quantitative calculation of the annihilation process of the magnetic annealing anisotropy in isothermal annealing accords exactly with the experimental results for iron–cobalt ferrites. There is a short discussion of the equilibrium density of vacancies in iron–cobalt ferrites using the results of statistical thermodynamical studies of the same system. Discussions of several theoretical and experimental results of iron–cobalt ferrites recently carried out in Japan are also presented. From results it is concluded that the decrease in the degree of oxidation simply makes the scale of the time constant of the relaxation process longer, therefore it is not consistent with the suggestion previously made that only cobalt ions near vacancies can rearrange rapidly.

539.2 : 538.2

10175 THE "PERMINVAR" EFFECT IN NiZn FERRITES, RICH IN IRON, CONTAINING A SMALL PROPORTION OF COBALT. A.Marais.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2170-2 (March 21, 1960). In French.

Two associated effects, first observed in the FeNiCo alloy series and known as the "perminvar" effects, have been studied in various Ni–Zn ferrites containing small additions of cobalt and sintered at 1150° C in oxygen. S.A.Ahern

539.2 : 538.2

10176 MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF RARE-EARTH ORTHOFERRITES AT LOW TEMPERATURES. R.M.Bozorth, V.Kramer and J.P.Remeika.

Physica, Vol. 24, Supplement, S161 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Single crystals of some of the orthorhombic rare-earth orthoferrites ($MFeO_3$), weighing about half a gram, were prepared by slow cooling of their solutions in PbO. Magnetic properties (for M = Eu, Gd, Dy, Ho, Er and Lu) have been investigated between 1.3° K and room temperature. In any one crystal at a given temperature the direction of spontaneous magnetization, σ_0, lies along one of the orthorhombic axes, and this axis may be different in different orthoferrites and may change with temperature. In $HoFeO_3$ the spontaneous magnetization per molecule changes with decreasing temperature from about 0.03 Bohr magneton parallel to [001] at 300° K, to about 3 Bohr magnetons parallel to [100] at 1.3° K. In $DyFeO_3$ σ_0 is parallel to [001] at 300° K, increases in magnitude at lower temperatures and then disappears below 30° K.

539.2 : 538.2

10177 RESONANCE EXPERIMENTS WITH SINGLE CRYSTAL YTTRIUM IRON GARNETS IN PULSED MAGNETIC FIELDS. M.R.Stiglitz and F.R.Morgenthaler.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 37S-38S (May, 1960).

A crystal sphere of YIG was placed in either a doubly resonant transmission type coaxial cavity or into a nonresonant transmission line device and biased with a d.c. magnetic field. A low power microwave signal in the S band frequency range (c.w. or pulsed) was used to excite resonance. Current pulses of approximately 1 μsec duration and low duty cycle were sent through a low impedance coil that was wound around the cavity or transmission line respectively. These pulses induced pulsed magnetic fields of the order of 1000 G which (vectorially) added to the existing d.c. field. A microwave receiver, attached to the cavity output, detected weak oscillations at higher or lower frequencies. Shifts of 280 Mc/s have been obtained with the cavity, and shifts of 1280 Mc/s above and 530 Mc/s below the driving frequency have been obtained with the transmission type device. The detected signal is associated with either the rise of the current pulse, or the decay, or two signals may appear simultaneously corresponding respectively to the rise and decay. This depends upon the angular relation of the d.c. field with respect to the cavity or transmission line.

539.2 : 538.2

10178 MAGNETIC INTERACTIONS AND DISTRIBUTION OF IONS IN THE GARNETS. S.Geller.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 30S-37S (May, 1960).

Since the discovery of the magnetic yttrium and rare earth iron garnets, a systematic investigation has been made of interactions of magnetic ions and the distribution of both magnetic and nonmagnetic ions in the garnets. The results of substitution of the tetravalent tin for Fe^{3+} ion in yttrium-iron garnet (balances by substitution of Ca^{2+} for Y^{3+} ions) have led to the development by Gilleo of a statistical interaction theory which accounts well for the spontaneous magnetizations and Curie temperatures of the system. This theory has been further strengthened by results from zirconium substituted yttrium-iron garnets and by its successful extension to substituted rare earth iron garnets. In the course of the investigations, many new garnets have been discovered. Several of these have enabled direct observations of the interactions between magnetic ions in dodecahedral and octahedral sites, dodecahedral and tetrahedral sites, octahedral sites only and tetrahedral sites only. The work on the garnets has also already been adequately extensive to lead to the establishment of some rather simple rules pertaining to site preference of ions entering the garnets.

539.2 : 538.2

10179 ANISOTROPY PROPERTIES OF HEXAGONAL FERRIMAGNETIC OXIDES. J.Smit, F.K.Lotgering and U.Enz.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 137S-141S (May, 1960).

The effects of the incomplete alignment of all magnetic moments of a sample in an applied field on the torque curves are discussed. Examples are given of torque curves determined for cobalt-substituted hexagonal compounds of the ferroxdure type with low anisotropy. It is shown that the characteristic details of these curves can be interpreted in terms of this incomplete alignment, both on a microscopic and an atomic scale.

539.2 : 538.2

10180 MAGNETIC ANISOTROPY IN FERRIMAGNETIC CRYSTALS. R.F.Pearson.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 160S-161S (May, 1960).

Absolute values of K_1, the first-order anisotropy constant, have been determined at different temperatures from torque measurements on single crystals of the following compositions: $Mn_xFe_{3-x}O_4$, where $0.7 \le x \le 1.0$; $Co_xMn_{1-x}Fe_2O_4$, where $0 \le x \le 0.25$; $Co_{0.04}Mn_{x-0.04}Fe_{2-x}O_4$, where $0.70 \le x \le 0.91$; $Ga_xFe_{3-x}O_4$, where $0 \le x \le 0.8$; $Sm_3Fe_5O_{12}$ and $Gd_3Fe_5O_{12}$. The magnetocrystalline

anisotropy of manganese ferrous ferrite was found to vary considerably with the concentration of ferrous ions (Fe^{2+}), some compositions even possessing a positive value of K_1 at room temperature, as previously found by Penoyer (1959). In these cases, K_1 becomes negative at low temperatures in contrast with the behaviour of cobalt-substituted crystals which are found to have rapidly increasing positive values of K_1 as the temperature is reduced. The anisotropy contribution of cobalt ions (Co^{2+}) substituted in manganese ferrous ferrite varies with crystals of different compositions. The experimental values of K_1 are compared wherever possible with present theories of magnetic anisotropy. In particular, the recent theory proposed by Slonczewski (1958) to explain the anisotropy of cobalt ions substituted in magnetite (Fe_3O_4) is found to be unsuccessful in the case of Co^{2+} ions in manganese ferrite ($MnFe_2O_4$). Measurements at low temperatures on the gallium-substituted magnetite crystals reveal an additional interesting effect. For certain crystals, the torque curves at 80° K exhibit considerable rotational hysteresis in fields above 10 000 Oe, when the material should certainly be saturated. This hysteresis is shown to be related to the ordering of the ferrous (Fe^{2+}) and ferric (Fe^{3+}) ions which takes place on the octahedral sites at low temperatures.

539.2 : 538.2

10181 HEXAGONAL FERRIMAGNETIC COMPOUND CONTAINING FLUORINE.

E.H.Frei, M.Schieber and S.Shtrikman.

Phys. Rev., Vol. 118, No. 3, 657 (May 1, 1960).

A partial substitution of the oxygen ions by fluorine in $BaO.6Fe_2O_3$ is reported. The new compound with a formula near to $BaF_2.2FeO.5Fe_2O_3$ has at room temperature a magnetization saturation of 72 c.g.s. units/gram compared to 67 c.g.s. units/gram for $BaO.6Fe_2O_3$. The specific gravity, Curie temperature, and unit cell dimensions are practically the same for both compounds.

539.2 : 538.2

10182 EFFECTS OF DOUBLE EXCHANGE IN MAGNETIC CRYSTALS. P.G. de Gennes.

Phys. Rev., Vol. 118, No. 1. 141-54 (April 1, 1960).

Discusses some effects of mobile electrons in some antiferromagnetic lattices. It is shown that these electrons (or holes) always give rise to a distortion of the ground state spin arrangement, since electron transfer lowers the energy by a term of first order in the distortion angles. In the most typical cases this results in: (a) a nonzero spontaneous moment in low fields; (b) a lack of saturation in high fields; (c) simultaneous occurrence of "ferromagnetic" and "antiferromagnetic" lines in neutron diffraction patterns; (d) both ferromagnetic and antiferromagnetic branches in the spin wave spectra. Some of these properties have indeed been observed in compounds of mixed valency such as the manganites with low Mn^{4+} content. Similar considerations apply at finite temperatures, at least for the (most widespread) case where only the bottom of the carrier band is occupied at all temperatures of interest. The free energy is computed by a variational procedure, using simple carrier wavefunctions and an extension of the molecular field approximation. It is found that the canted arrangements are stable up to a well-defined temperature T . Above T the system is either antiferromagnetic or ferromagnetic, depending upon the relative amount of mobile electrons. This behaviour is not qualitatively modified when the carriers which are responsible for double exchange fall into bound states around impurity ions of opposite charge. Such bound states, however, will give rise to local inhomogeneities in the spin distortion and to diffuse magnetic peaks in the neutron diffraction pattern. The possibility of observing these peaks and of eliminating the spurious spin-wave scattering is discussed.

539.2 : 538.2

10183 LATTICE STATISTICS IN A MAGNETIC FIELD. I. A TWO-DIMENSIONAL SUPER-EXCHANGE ANTIFERROMAGNET. M.E.Fisher.

Proc. Roy. Soc. A, Vol. 254, 66-85 (Jan. 19, 1960).

The partition function of a two-dimensional "superexchange" antiferromagnet in an arbitrary magnetic field is derived rigorously. The model is a decorated square lattice in which magnetic Ising spins on the bonds are coupled together via non-magnetic Ising spins on the vertices. By use of the decoration transformation all the thermodynamic and magnetic properties of the model are derived from Onsager's solution for the standard square lattice in zero field. The transition temperature $T_t(H)$ is a single-valued, decreasing function of the field H. The energy and the magnetization are continuous function of T for all magnetic fields; but the specific heat and the temperature gradient of the magnetization become infinite as $-\ln|T - T_t|$. The initial (H = 0) susceptibility is a continuous and smoothly varying function of T with a maximum 40% above the critical point; but $\partial\chi/\partial T$ becomes infinite at $T = T_c$. In a non-vanishing field the susceptibility has a logarithmic infinity at $T = T_t$. For small fields the behaviour near the critical point is given by

$$\chi \cong (N\mu^2/kT)\{2 - \sqrt{2} - D(T - T_c)\ln|T - T_c| - D'H^2\ln|T - T_c|\},$$

where D and D' are constants.

539.2 : 538.2

10184 NEUTRON DIFFRACTION STUDIES OF ANTIFERROMAGNETISM IN CrF_2 AND $CrCl_2$.

J.W.Cable, M.K.Wilkinson and E.O.Wollan.

Phys. Rev., Vol. 118, No. 4, 950-5 (May 15, 1960).

Neutron diffraction observations were made on powder samples of CrF_2 and $CrCl_2$ from 296° to 4.2° K. These materials, which have crystal structures similar to rutile but distorted from tetragonality, become antiferromagnetic at low temperatures with different magnetic structures. For CrF_2 the magnetic unit cell is identical with the chemical cell and the moments at the corner sites are directed oppositely to those at the centre of the cell. The magnetic unit cell of $CrCl_2$ requires doubling of the b and c axes of the orthorhombic chemical cell and the structure consists of ferromagnetic (011) planes with adjacent planes antiparallel. In neither case were the intensities compatible with a magnetic axis directed along a simple crystallographic direction. Unique magnetic axes could not be definitely established but the data suggest that they lie parallel to the longest Cr–F and Cr–Cl bonds. Neel temperatures of 53° and 20° K were observed for CrF_2 and $CrCl_2$, respectively.

539.2 : 538.2

10185 THE CAUSES OF THE ANOMALOUS PHYSICAL PROPERTIES OF THE INVAR-TYPE ALLOYS.

E.I.Kondorskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 6 (12), 1819-20 (Dec., 1959).

In Russian.

It has been shown (Abstr. 13446 of 1959) that the 73Fe/9Ni/18Cr alloy becomes antiferromagnetic at 40° K, from which it can be inferred that the exchange integral, I_1, for neighbouring Fe ions in f.c.c. lattice is negative; at the same time, the exchange integrals I_2 and I_{12} for similarly placed Ni and Ni + Fe ions are positive. Starting from these considerations, the author shows that the anomalous properties of the Invar-type alloys can be attributed to their "latent" antiferromagnetism, associated with the presence of ions with antiparallel spins. M.H.Sloboda

539.2 : 538.2

10186 ON VARIATION OF MAGNETIC SUSCEPTIBILITY WITH TEMPERATURE OF PYROLUSITE (POLYCRYSTALLINE ORE OF MnO_2). J.N.Das.

J. Electronics and Control, Vol. 7, No. 4, 367-9 (Oct., 1959).

Room-temperature mass susceptibilities of seven samples varied from 31 to 1234 × 10^{-6}. Measurements up to about 700° C showed that the susceptibility has a sharp maximum within the temperature range from 455° to 560° C. These temperatures are much greater than that reported for antiferromagnetic MnO_2. R.C.Kell.

539.2 : 538.2

10187 NEUTRON DIFFRACTION STUDY OF THE MAGNETIC PROPERTIES OF RARE-EARTH-IRON PEROVSKITES.

W.C.Koehler, E.O.Wollan and M.K.Wilkinson.

Phys. Rev., Vol. 118, No. 1, 58-70 (April 1, 1960).

$NdFeO_3$, $HoFeO_3$ and $ErFeO_3$ were studied at temperatures ranging from 955° to 1.25° K. The iron ions in each of these compounds undergo a transition to an antiferromagnetic configuration in which each moment has six oppositely directed moments at nearest neighbour distances. The Neel temperatures are 760°, 700° and 620° K, respectively, for the compounds of Nd, Ho, and Er. The moment directions in $HoFeO_3$ and $ErFeO_3$ are parallel and antiparallel to the orthorhombic [100] direction at room temperature : at 43° K the moments are found to be in a (1$\bar{1}$0) plane. In $HoFeO_3$ the iron-ion moments at 1.25° K are parallel to [001]; in $ErFeO_3$ at the same temperature they are parallel to [100]. The magnitudes of the ordered iron moments at temperature saturation are 4.5$_5$, 4.6$_0$, and 4.6$_4$ Bohr magnetons in $NdFeO_3$, $HoFeO_3$, and $ErFeO_3$, respectively. In the liquid helium temperature range, magnetic ordering transitions of the rare-earth ions in $HoFeO_3$ (T_N = 6.5° K) and $ErFeO_3$ (T_N = 4.3° K) were observed. The Er^{+3} ion moments form a nearly

ideal antiferromagnetic configuration in which a chain of parallel moments is surrounded by four chains of oppositely directed moments at nearest neighbour distances. In this compound the Er^{+3} ion moments are parallel and antiparallel to [001] and at 1.25°K have a magnitude of 5.8 Bohr magnetons. In $HoFeO_3$ the ions are ordered in a distorted antiferromagnetic configuration in which, at 1.25°K, each Ho^{+3} moment with magnitude of 7.5 Bohr magnetons, makes an angle, in the (001) plane, of about 27° with the [010] direction so as to produce a net ferromagnetic moment of 3.4 Bohr magnetons per $HoFeO_3$ molecule parallel to [100].

539.2 : 538.2

10188 NEUTRON DIFFRACTION STUDIES OF ANTIFERROMAGNETIC RARE EARTH COMPOUNDS. W.C.Koehler, E.O.Wollan, M.K.Wilkinson and J.W.Cable. Physica, Vol. 24, Supplement, S157 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A number of low transition temperature antiferromagnetic materials has been under investigation. Among these are the sesquioxides of erbium and holmium. Neutron diffraction experiments on polycrystalline samples have been carried out at temperatures ranging from room temperature to 1.25°K and in applied magnetic fields up to 16.3 kOe. Erbium sesquioxide undergoes a transition to an antiferromagnetically ordered state, in the absence of external fields, at 3.6°K. At 1.25°K the erbium ions have an average ordered moment of 5.7 Bohr magnetons which is substantially lower than the maximum possible ordered moment of 9.0 Bohr magnetons, and this discrepancy is attributed to the effects of crystalline field interactions. Holmium sesquioxide, in the absence of applied fields, exhibits diffraction effects characteristic of short range antiferromagnetic ordering only, at the lowest temperature studied. In applied fields, however, coherent magnetic reflections characteristic of an antiferromagnetic configuration are observed, and a complex H–T phase diagram has been obtained.

Magnetic Resonances

539.2 : 538.27

10189 ANISOTROPY OF THE LANDÉ FACTOR OF YTTERBIUM IN A GARNET TYPE GALLATE. Y.Ayant and J.Thomas. C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2688-90 (April 11, 1960). In French.

In order to interpret the experimentally observed anisotropy of the Lande factor (g-value) for the Yb ion in gallates, the Hamiltonian of this ion in a crystal field was determined, taking account of the deviation from cubic symmetry in the neighbourhood of the ion.

S.A.Ahern

539.2 : 538.27 : 538.56

10190 FINITE AMPLITUDE ELECTROMAGNETIC WAVES IN GYROMAGNETIC MEDIA. B.A.Auld. J. appl. Phys., Suppl. to Vol. 31, No. 5, 106S-107S (May, 1960).

A perturbation method is developed for obtaining forced steady-state solutions to Maxwell's equations and the torque equation subject to the usual boundary condition. This procedure is applied to the scattering of a normally incident plane wave from a semi-infinite gyromagnetic slab and numerical results are presented.

539.2 : 538.27

10191 THE INFLUENCE OF COHERENT MAGNETIC DIPOLE RADIATION ON MAGNETIC RESONANCE. G.V.Skrotskii and A.A.Kokin. Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 802-4 (Sept., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 3, 572-3 (March, 1960).

Corrections to the relaxation time, necessitated by the effect of the radiation field, are computed. The effect of the resonator on the nature of the observed phenomenon is taken into account.

539.2 : 538.27

10192 "FOLDOVER" EFFECTS CAUSED BY SPIN WAVE INTERACTIONS IN FERROMAGNETIC RESONANCE. H.Suhl. J. appl. Phys., Vol. 31, No. 5, 935-6 (May, 1960).

539.2 : 538.27

10193 MAGNETOSTATIC MODES OF A FERROMAGNETIC SLAB. R.W.Damon and J.R.Eshbach. J. appl. Phys., Suppl. to Vol. 31, No. 5, 104S-105S (May, 1960).

The characteristic modes of a thin slab magnetized in its plane are obtained in the magnetostatic limit, and the mode spectrum and configuration are discussed. The wavelength dependence of magnetostatic mode density is determined and utilized to establish a connection to the modes obtained in the spin-wave approximation. In this geometry the modes lying above the spin-wave band are surface waves, decaying toward the interior of the slab, while volume modes occur in the same frequency range as the long-wavelength limit of the spin-wave band of an infinite medium. The mode density exhibits poles at the upper and lower frequency limits of the surface mode spectrum. The surface modes become statistically less important at shorter wavelengths because the ratio of surface mode density to volume mode density varies approximately as $1/|k|$.

539.2 : 538.27

10194 GALVANOMAGNETIC EFFECTS IN FERROMAGNETIC RESONANCE. M.H.Seavey, Jr. J. appl. Phys., Suppl. to Vol. 31, No. 5, 216S-217S (May, 1960).

The d.c. voltage generated across the surface of a thin ferromagnetic film during ferromagnetic resonance is described. The effect has been analysed in terms of the combined action of the extraordinary Hall effect and a magnetoresistance effect. The d.c. character arises from the dependence of the voltage on double products of microwave fields. Data are presented, and it is shown that the theory gives the proper order of magnitude of the effect. Also, the experimental voltage versus steady magnetic field curves show that the extraordinary Hall effect plays the principal role. The voltage provides a new and sensitive means of studying ferromagnetic resonance effects in thin films.

539.2 : 538.27

10195 EFFECTS OF SURFACE IRREGULARITIES ON SINGLE CRYSTAL RESONANCE PARAMETERS. C.R.Buffler. J. appl. Phys., Suppl. to Vol. 31, No. 5, 222S-224S (May, 1960).

Measurements of ferromagnetic resonance line width, and anisotropy of line width of yttrium iron garnet and manganese zinc ferrite single crystals as a function of surface irregularities from 8 to 75 μ, and frequency from 2 to 16 kMc/s, are presented. These measurements indicate that the frequency dependence of the line width and line width anisotropy in these materials for varying degrees of surface roughness can be interpreted with respect to spin wave scattering theories. In this case, the surface irregularities act as scattering centres for the uniform precession, causing a loss of energy into degenerate spin wave states with wavelengths corresponding to the size of the irregularities.

539.2 : 538.27

10196 EFFECT OF SPECIMEN SHAPE ON FERROMAGNETIC RESONANCE IN A STRONG RADIOFREQUENCY FIELD. G.V.Skrotskii and Yu.I.Alimov. Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1267-71 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36 (9), No. 4, 899-901 (Oct., 1959).

Analyses the exact solutions of the Landau–Lifshits equations for nonspherical ferromagnetic specimens in a radio-frequency field of arbitrary amplitude. An expression is derived for the threshold field h_c, above which instability in the motion of the magnetization vector begins. The slow decrease of the magnetization component and the shift of the resonance field strengths $h_0 > h_c$ are explained. It is shown that for $h_0 > h_c$, the height of the absorption peak decreases and its width increases.

539.2 : 538.27 : 621.318.132

10197 L-BAND FERROMAGNETIC RESONANCE EXPERIMENTS AT HIGH PEAK POWER LEVELS. E.Schlömann, J.H.Saunders and M.H.Sirvetz. I.R.E. Trans Microwave Theory and Tech., Vol. MTT-8, No. 1, 96-100 (Jan., 1960).

Ferromagnetic resonance absorption at high peak power levels has been observed at 1300 Mc/s in yttrium–gadolinium garnets and in a nickel ferrite–aluminate. In agreement with theoretical predictions, the critical field characterizing the onset of nonlinear effects in a series of yttrium–gadolinium garnet disks of a given shape was found to be very sensitively dependent on the gadolinium content. Similarly, for samples of a given composition, the critical

field strength was sensitively dependent on the shape of the sample in agreement with theoretical predictions. At moderate power levels the susceptibility varies linearly with the square of the r.f. magnetic field strength over an appreciable range. This result can be understood in terms of an extension of Suhl's theory. The results can be used to predict the high-power performance of these materials when used in isolators.

539.2 : 538.27

10198 INITIAL-PERMEABILITY SPECTRA OF MICROSCOPIC IRON-OXIDE PARTICLES.

W.F.Brown, Jr, J.P.Hanton and A.H.Morrish.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 214S-215S (May, 1960).

The magnetic resonance of single-domain ferromagnetic particles in zero applied steady magnetic field is studied theoretically and experimentally. The axial ratio of the powder particles deduced from the resonance measurements agrees reasonably well with optical data. This is strong evidence regarding the origin of the observed resonance.

539.2 : 538.27

10199 INTERNAL FERROMAGNETIC RESONANCE IN MAGNETITE. J.C.Anderson and B.Donovan.

Proc. Phys. Soc., Vol. 75, Pt 1, 149-51 (Jan., 1960).

The complex permeability has been measured of a colloidal suspension of magnetite (Fe_3O_4) over the temperature range 30°-90° C. The results are very similar to those previously obtained in pure nickel and nickel-iron alloys where the resonance phenomena were attributed to an internal field arising from the anisotropy energy. In magnetite the internal field is smaller than one would anticipate from the measured anisotropy constants but this may be due to the superparamagnetism of the small particles. J.M.Baker

539.2 : 538.27

10200 FERROMAGNETIC RELAXATION MECHANISM FOR M_Z IN YTRRIUM IRON GARNET.

M.Sparks and C.Kittel.

Phys. Rev. Letters, Vol. 4, No. 5, 232-4 (March 1, 1960).

M_Z is expected to relax by magnetic dipole interaction with thermal spin waves. The theoretical result, $1/T_1 \cong 0.74 \times 10^8\ T(^\circ K)$, in agreement with the experimental value of $1/T_1 = 10^8\ T(^\circ K)$.

D.J.Oliver

539.2 : 538.27

10201 A SURVEY OF FERROMAGNETIC RESONANCE IN SMALL FERRIMAGNETIC ELLIPSOIDS.

F.R.Morgenthaler.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 95S-97S (May, 1960).

This paper discusses the response of the magnetization in a small ferrimagnetic ellipsoid, magnetized in an arbitrary direction and excited by spatially uniform microwave magnetic fields, when a typical spin wave is present. The generalized Kittel frequency is given, and possible frequency generation processes appropriate to the ellipsoidal geometry are treated. If the ellipsoid is magnetized at an angle to a principal axis, time-varying components of demagnetizing field at the fundamental frequency occur in the longitudinal direction, as well as transverse components varying at this frequency. Previous analyses have not included such a possibility and certain interesting solutions have, therefore, been missed. In particular, it is found that subharmonics as well as harmonics may be created when the driving field exceeds a certain threshold power. The particular case of the half-frequency resonance is considered and the conditions for the minimum threshold are given. The generalized Suhl spin wave spectrum is found, together with the coupling relations between the uniform precession and the spin wave. The Suhl first and second order instability thresholds, for the general ellipsoid, are formulated, and a zero order coupling is established for certain transient states of the magnetization. In addition, direct parametric coupling between a longitudinal pumping field and both the uniform precession and the spin waves is discussed.

539.2 : 538.27

10202 USE OF MAGNETOSTATIC MODES AS A RESEARCH TOOL. R.L.White.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 86S-94S (May, 1960).

The use of ferrimagnetic resonance and in particular of the magnetostatic modes of spheres to obtain information on basic physical magnetic parameters is discussed. The effects of random and systematic deviation of the experimental situation from the theoretical upon the determination of $4\pi M$, γ, and the magnetic anisotropy constants are treated. A summary is also given of the use of line width and r.f. power saturation measurements on the magnetostatic modes to obtain information on the spin-wave spectrum of the material.

539.2 : 538.27

10203 MAGNETIC ANISOTROPY FROM THE MAGNETOSTATIC MODES. I.H.Solt, Jr and P.C.Fletcher.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 100S-102S (May, 1960).

The differential equations for the magnetostatic modes in ferrimagnetic resonance have been rederived including the anisotropy torques. Exact solutions have been obtained for four of the low order modes of a sphere. These solutions differ in general from those for the differential equations not including anisotropy. Excellent agreement was found between measured resonance fields and those predicted by the modified theory.

539.2 : 538.27

10204 FERRIMAGNETIC RESONANCE AT HIGH POWER. M.T.Weiss.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 103S (May, 1960).

Ferrimagnetic resonance experiments have been performed on single-crystal manganese ferrite at high microwave powers. The variation of susceptibility with power level is in good agreement with Suhl's recent theoretical treatment of the saturation process in which scattering of the uniform precession at impurities and imperfections is taken into account. The results show that the ratio of intrinsic to scattering decay constants is close to zero, so that χ'' decreases gradually at power levels substantially below the theoretical critical signal level. At very high power levels various anomalous effects appear such as bistabilities, line asymmetries, and flat topped absorption lines.

539.2 : 538.27

10205 SATURATION EFFECTS IN FERRIMAGNETIC RESONANCE. P.E.Seiden.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 225S-226S (May, 1960).

Saturation curves of susceptibility as a function of r.f. magnetic field have been measured for a number of samples of polycrystalline yttrium iron garnet of varying linewidth. The curves exhibit a region of susceptibility linear in $1/h_{rf}$ at high r.f. powers. The region of the initial decline in susceptibility is linear in h_{rf}^2, which is predicted both by a small signal relation derived from Callen's ferromagnetic dynamical equation and by a calculation of Schlomann which includes inhomogeneity interactions. A new method of determining the critical field for spinwave build-up is discussed. This method takes account of the fact that the initial decline in susceptibility is not simply due to the Suhl mechanism for saturation in ferrites.

539.2 : 538.27

10206 RESONANCE LINE WIDTHS OF SINTERED NICKEL FERRITES HAVING LOW POROSITIES.

L.G.Van Uitert, R.R.Soden and F.W.Swanekamp.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 226S-227S (May, 1960).

The evolution of gas during sintering can act as a source of line broadening in low porosity ferrites. When this occurs there are systematic dependencies of ΔH (line width) upon sintering conditions but not upon porosity. Nickel ferrites sintered under such non-ideal conditions show minima in ΔH as a function of cobalt content. When the same materials are sintered under more ideal conditions, ΔH increases linearly with cobalt. ΔH varies as the reciprocal of saturation magnetization for modified nickel ferrites prepared under the most ideal conditions. The effects of anisotropy field and dipole narrowing on ΔH are evident.

539.2 : 538.27

10207 VOLUME DEPENDENCE OF FERRIMAGNETIC RESONANCE PROPERTIES IN $Ni_{1-x}Co_xFe_2O_4$.

I.P.Kaminow.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 220S-221S (May, 1960).

A microwave resonance apparatus for measuring K_1/M, K_2/M, $4\pi_{eff}$, linewidth and magnetization as functions of pressure to 10 000 atm is described. At this pressure the volume of nickel ferrite is reduced by only 0.68% but significant changes in magnetic properties are observed. The results of measurements for values of x of 0, 0.05, 0.10 are discussed in terms of Slonczewski's anisotropy theory.

539.2 : 538.27 : 621.318.132

10208 HIGH POWER FERROMAGNETIC RESONANCE AT X-BAND IN POLYCRYSTALLINE GARNETS AND FERRITES. J.J.Green and E.Schlömann.

I.R.E. Trans Microwave Theory and Tech., Vol MTT-8, No. 1, 100-3 (Jan., 1960).

Resonance experiments were performed at X-band on spherical samples of polycrystalline yttrium garnet, yttrium–gadolinium garnet, yttrium–holmium garnet and nickel–cobalt ferrite. The r.f. field strength extended up to 60 Oe. In the case of yttrium garnet the samples differed considerably in density and hence in linewidth. At fairly low power levels the susceptibility at resonance varied linearly with the square of the r.f. magnetic field strength. At high power levels the susceptibility was inversely proportional to the amplitude of the microwave magnetic field. The "spin-wave linewidth" ΔH_k was inferred by extrapolation from the behaviour at very high powers. It was found that ΔH_k is, to a large extent, independent of the linewidth ΔH observed by the usual low power experiments. In particular ΔH_k was found to be essentially the same (approximately 4 Oe) for all yttrium iron garnets (single crystals and polycrystals with linewidth varying between 1.8 Oe and 450 Oe). On the other hand, ΔH_k increased very rapidly if the yttrium was partially substituted by holmium ($\Delta H_k \sim 11$ Oe for 1% substitution).

539.2 : 538.27

10209 MICROWAVE RESONANCE IN RARE EARTH IRON GARNETS. C.Kittel.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 11S-13S (May, 1960).

An elementary discussion is given of the theory of g values and line widths in ferromagnetic resonance in certain rare earth garnets. The experimental facts are reviewed briefly.

539.2 : 538.27

10210 INSTABILITY OF MAGNETIC RESONANCE IN SINGLE CRYSTAL SPHERES OF YTTRIUM IRON GARNET. J.I.Masters.

J. appl. Phys., Suppl.to Vol. 31, No. 5, 41S-42S (May, 1960).

Instabilities in YIG spheres that exist above certain threshold power values of c.w. microwave field are studied using samples of about $\frac{1}{4}$ - $\frac{1}{2}$ mm diameter, that have low power line widths of 1 Oe or less. Whereas the characteristic behaviour such as asymmetrical line shape, "jump" effect etc. is somewhat similar to that reported for disks, the phenomenon is generally different. It has been determined that this instability, which can occur at c.w. power levels below the threshold for significant spin wave growth, is due entirely to the heating effect of resonance absorption upon the anisotropy energy of the crystal lattice. As a result, the instability is characterized by a threshold curve that follows both the extrema and symmetry of the anisotropy curve for a given orientation. A straightforward theoretical explanation based on familiar relationships is outlined which fits the instability threshold versus orientation curve. The temperature instability provides a technique for measuring the "g" factor that is believed to be more direct than previous methods.

539.2 : 538.27

10211 FERRIMAGNETIC RESONANCE IN IMPURITY DOPED YTTRIUM IRON GARNET (YIG).

J.F.Dillon, Jr and J.W.Nielsen.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 43S-44S (May, 1960).

A research programme aimed at understanding earlier line width and anisotropy measurements on YIG has led to a study of ferrimagnetic resonance in doped crystals. YIG crystals have been grown containing appropriate concentrations (~0.01 to 5.0 at. %) of various impurities, including the 4f rare earth elements, members of the iron transition group, and several nonmagnetic elements. This paper gives new results for the variation of the field for resonance with crystal direction at several temperatures in the liquid hydrogen and liquid helium range. In the case of Ho, sharp peaks in the Hres versus angle curve are seen which vary rapidly with temperature. The corresponding curves for the Dy- containing sample do not show such sharp variations in (110), and at least in part do not vary with temperature below about 4°K. Though Kittel's recent theoretical results should apparently apply to the peaks in the case of Ho, his results for the temperature dependence of the anomaly height and width do not correspond with the data obtained here.

539.2 : 538.27 : 538.56 : 621.374.4

HARMONIC GENERATION IN A FERRIMAGNETIC DISK.
See Abstr. 9187

539.2 : 538.27

10212 EXCITATION OF SPIN WAVES IN FERROMAGNETS : EDDY CURRENT AND BOUNDARY CONDITION EFFECTS. P.Pincus.

Phys. Rev., Vol. 118, No. 3, 658-64 (May 1, 1960).

The boundary condition for the transverse magnetization is derived when there is a surface anisotropy field H_s. Writing the transverse magnetization as $\alpha \sin kz + \cos kz$, then

$$\alpha/\beta = -\tfrac{1}{2}ka + (H_s/H_e ak),$$

where H_e is the exchange field and a the lattice constant. A similar result is found when there is an antiferromagnetic surface layer. For $H_s \neq 0$ spin-wave modes can be excited by a uniform r.f. field in a ferromagnet. The power absorbed in each mode in an insulator is calculated as a function of the surface anisotropy field. The excitation of the exchange modes is calculated for a metal with eddy-current damping. The eddy currents are found to have a large effect only on long wavelength spin waves. The line shape in a thick metal plate is calculated for H_0 normal to the plate.

539.2 : 538.27

10213 A METHOD OF ANALYSING THE FORM OF ELECTRON PARAMAGNETIC RESONANCE LINES. N.N.Tikhomirova and V.V.Voevodskii.

Optika i Spektrosk, Vol. 7, No. 6, 829-32 (Dec., 1959). In Russian.

The form of electron paramagnetic resonance (e.p.r.) lines is analysed in order to establish the nature of binding between an unpaired electron and the atoms surrounding it. The analysis is applied to the e.p.r. lines of polyvinyl chloride "cokes" and the results are related to the structure of the cokes and the effect of coking temperature on this structure. A.Tybulewicz

539.2 : 538.27

10214 PARAMAGNETIC RELAXATION IN SINGLE CRYSTALS AT LIQUID HELIUM TEMPERATURES. T.Haseda.

Physica, Vol. 24, Supplement, S162-S163 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Paramagnetic relaxations in single crystal samples are measured. In $CoNH_4$–Tutton salt, the anomalous tendency of $d\rho SL/dH_C$, is found also in single crystals. Anisotropy is not observed in the tendency of $d\rho SL/dH_C$ neither in the cobaltous salt nor in the manganous salt, which has normal tendency of $d\rho SL/dH_C$. The magnetic specific heat b/C is determined in the above mentioned salts and in $NiSiF_6.6H_2O$ using single crystal samples. Quite unexpected results have been found in $NiSiF_6.6H_2O$ showing an anisotropy in b/C. These facts are considered by Moriya to show the difficulty of using Casimir–du Pré's theory where it is assumed that the spin temperature T_S is always established.

539.2 : 538.27

10215 ELECTRON SPIN-LATTICE RELAXATION TIMES. M.W.P.Strandberg, C.F.Davis and R.L.Kyhl.

Physica, Vol. 24, Supplement, S163 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A discussion of the experimental problems encountered in making spin-lattice relaxation measurements in electron paramagnetic systems at low temperature is presented. Gadolinium and chrome ion spin-lattice relaxation times measured by a pulse saturation technique in the time domain, are given. The relation of these spin-lattice relaxation times to relaxation times measured in the frequency domain by observing a saturation parameter is discussed.

539.2 : 538.27

10216 THE INFLUENCE OF PARAMAGNETIC RESONANCE SATURATION ON THE FARADAY EFFECT. J.M.Daniels and H.Wesemeyer.

Physica, Vol. 24, Supplement, S164 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The Faraday effect has been observed for neodymium ethylsulphate at 1.4°K using green mercury light (5461 A) in fields up to 3 kG. The neodymium ethylsulphate crystal was contained in a cavity resonant at 3 cm wavelength. When microwave power was fed into the cavity, the Faraday rotation was reduced at fields around 1.8 kG due to saturation of the paramagnetic resonance. This phenomenon has been used to determine spin-lattice relaxation times for neodymium ethylsulphate.

539.2 : 538.27

10217 SOME THERMODYNAMICAL CALCULATIONS ON PARAMAGNETIC RELAXATION IN LOW FREQUENCY MAGNETIC FIELDS. L.C.Van der Marel.

Physica, Vol. 24, Supplement, S164-S165 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Experiments carried out in low frequency magnetic fields and evaluations of the relaxation time lead one to conclude that the observed relaxation phenomenon is probably not caused by a delayed spin–lattice heat transfer. On account of this an extension of the original thermodynamic theory of Casimir and Du Pré has been developed. The basic supposition is that the salt may be looked upon as composed of different systems: (1) the spin system, (2) that part of lattice oscillators which is in immediate heat contact with the spin system and (3) the remaining part of lattice oscillators. These systems may exchange energy with each other and those mentioned under (2) and (3) with the surrounding cooling liquid as well; each is characterized by an effective temperature. Energy exchange between two of them is proportional to their difference in temperature. For some simplified cases the dispersion and absorption curves have been calculated and constructed. When there are two heat transfers in series, these curves may formally be described by a sum of two Debye curves. Also some of these curves, which follow from a calculation of Eisenstein in which a finite heat resistance of the lattice was introduced, have been constructed for different values of the heat resistance. The experimental curves of some alums and tutton salts are compared with the calculated ones. When there is no heat contact with the bath there is proper agreement at very low frequencies and this offers the possibility of calculating the specific heat of the lattice and of a non-magnetic added material. In many cases, at those frequencies where the relaxation phenomenon appears, no agreement is obtained.

539.2 : 538.27

10218 PARAMAGNETIC RELAXATION IN COBALT SALTS AT HELIUM TEMPERATURES. J.Van den Broek.

Physica, Vol. 24, Supplement, S165-S166 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Measurements have been made by means of the Hartshorn bridge on a set of the compounds $Co_{1/(n+1)}Zn_{n/(n+1)}(NH_4)_2.(SO_4)_2.6H_2O$ and $Co_{1/(n+1)}Zn_{n/(n+1)}SiF_6.6H_2O$. The relaxation times of the cobalt ammonium sulphates are found to depend in a rather complicated way on the parallel magnetic field; also the specific heat at constant magnetic moment obtained from the adiabatic susceptibility shows anomalies. After a series of measurements on powders with dilutions 1 : n = 1 : 0, 1 : 5, 1 : 10 and 1 : 20, these anomalies were studied in more detail on 1 : 10 and 1 : 40 single crystals. In the 1 : 10 crystals a resonance-like structure is found of the curve giving the relaxation time as a function of the parallel field at higher fields. The specific heat anomaly occurs in a restricted range of magnetic fields; in this same range double relaxation effects are found. All these anomalous effects show a marked crystalline anisotropy. In the 1 : 40 diluted crystals the specific heat anomalies and double relaxations are absent. This may suggest that they have to do with interactions between nearest neighbours. In the silico fluoride crystals (1 : 0 and 1 : 10) no anomalous behaviour has been found.

539.2 : 538.27

10219 THEORY OF PARAMAGNETIC RESONANCE IN SYSTEMS CONTAINING TWO KINDS OF MAGNETIC MOMENTS.

A.A.Kokin and G.V.Skroyskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 482-9 (Aug., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 2, 342-6 (Feb., 1960).

Equations of motion for the partial magnetizations of a system containing two kinds of interacting magnetic moments situated in a weak variable magnetic field are obtained by methods of thermodynamics of irreversible processes. The same equations can be derived from the microscopic theory in the case of sufficiently rapid thermal fluctuations of the local fields. The relaxation times and the shift of the resonance frequency are computed. It is shown that a universal relation, similar to the Kramers–Kronig relation, exists between the quantities determining the transverse relaxation time and the resonance frequency shift.

539.2 : 538.27

10220 ELECTRON SPIN RELAXATION IN FERROMAGNETIC INSULATORS.

R.C.LeCraw, R.C.Fletcher and E.G.Spencer.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 95S (May, 1960).

A review is presented of the various approaches in the literature to describe electron spin relaxation in ferromagnetic insulators. Emphasis is placed on recent developments involving scattering into spin waves due to inhomogeneities in the magnetization, particularly as it pertains to relaxation in narrow line width materials. See also Abstr. 6258 of 1960.

539.2 : 538.27

10221 PARAMAGNETIC RESONANCE OF IMPURITIES IN $CaWO_4$. I. TWO S-STATE IONS.

C.F.Hempstead and K.D.Bowers.

Phys. Rev., Vol. 118, No. 1, 131-4 (1960).

Paramagnetic resonance measurements were made on Mn^{2+} and Gd^{3+} ions in single crystals of $CaWO_4$ grown from the melt. In both cases the four different possible substitutional sites in the unit cell lead to identical resonance spectra with tetragonal symmetry. The splitting of the electronic levels in zero magnetic field is much greater for Gd^{3+} than for Mn^{2+}, e.g., b_2^0 is 6.7 times greater and b_4^4 is 13 times greater. (b_n^m is the coefficient of an operator function having the same transformation properties as the corresponding spherical harmonic Y_n^m used in expanding the crystalline electric field). The large value of b_2^0 ($-0.0917\ cm^{-1}$) for Gd^{3+} makes it a potentially useful material for three-level masers. The lines are narrow, and the h.f.s. due to $Gd^{155,157}$ is well resolved: the ratio A^{155}/A^{157} of the hyperfine splitting constants for the two isotopes was determined as 0.763 ± 0.006.

539.2 : 538.27

10222 PARAMAGNETIC RELAXATION IN COBALTOUS SALTS AT LIQUID HELIUM TEMPERATURES.

T.Haseda and E.Kanda.

Physica, Vol. 24, Supplement, S166 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Paramagnetic relaxation has been measured in some cobaltous salts at liquid helium temperatures and an anomaly found in the field dependence of spin–lattice relaxation time such as $d_\rho SL/dH_C < 0$. Salts examined were $CoNH_4$-Tutton, CoK-Tutton, $CoSO_4.7H_2O$, $CoI_2.9H_2O$, $CoSiF_6.6H_2O$, etc. In all these cobaltous salts, $d_\rho SL/dH_C < 0$, at least when the external field H_C is lower than 1000 gauss. A second problem which is reported, concerns paramagnetic relaxation in two-ion systems such as Co–Fe, Co–Ni and so on. If a certain amount of the cobaltous ions is replaced by ferrous ions, $d_\rho SL/dH_C$ becomes positive and if replaced by nickelous ions, it remains negative, but b/C becomes large at large external field. Besides these cobaltous systems, the results of systems such as Co–Zn, Cu–Fe, Cu–Ni, are reported.

539.2 : 538.27

10223 SATURATION OF PARAMAGNETIC RESONANCE IN $CuK_2(SO_4)_2 6H_2O$ AND $CrK(SO_4)_2 12H_2O$.

B.Bölger, K.J.Van Damme, J.M.Noothoven van Goor and C.J.Gorter.

Physica, Vol. 24, Supplement, S163-S164 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: In view of the existing discrepancies between the relaxation times derived from the direct relaxation method and from the saturation method, a series of saturation experiments have been performed with a microwave bridge at 9400 Mc/s. A previous paper predicts the saturation curves $1/\chi'$ versus h.f. power to rise faster at low power than at high powers. Undiluted $CuK_2(SO_4)_2 6H_2O$ with a static magnetic field, H, parallel to the [100] axis has been saturated at temperatures between 1.4°K and 20°K. Only a slight change in slope of the saturation curves takes place. At helium temperatures τ is proportional to 1/T. In the case of CrK-alum various transitions have been saturated with H parallel to the [111] and to the [100] directions. The temperature dependence is different for different directions. For H parallel to the [100] direction H is proportional to T^{-2}.

539.2 : 538.27

10224 CROSS RELAXATION STUDIES IN DIAMOND.

P.P.Sorokin, G.J.Lasher and I.L.Gelles.

Phys. Rev., Vol. 118, No. 4, 939-45 (May 15, 1960).

A microwave double resonance experiment performed on the paramagnetic nitrogen centers in diamond shows that in this system cross relaxation occurs via a four spin flip mechanism which exactly conserves Zeeman energy. In this process, which was first postulated by Bloembergen et.al. (Abstr. 8354 of 1959), two spins of the

center line make a downward transition while a spin belonging to each satellite makes an upward transition. Simple rate considerations for this process indicate that if a saturating microwave field is suddenly applied to one of the three lines of the nitrogen spectrum, a weak probing microwave signal at either of the two other lines should register a definite change in absorption in a time T_{21}. Specifically, if T_{21} is much less than other relaxation times of the system, then setting the pump upon the center line should force the absorption at either satellite to drop to zero. Setting the pump at the position of one of the satellites, on the other hand, should reduce the center line absorption to $\frac{3}{5}$ its thermal equilibrium value but should increase the absorption measured at the other satellite by the factor $\frac{9}{5}$. This behaviour was precisely observed at 1.6°K, using a bi-modal cavity. By resolving the rate at which a satellite decays to zero when the pump is set on the center line, T_{21} is measured for all five satellites in the three principal orientations: $H_0 \parallel [100]$, $H_0 \parallel [110]$, and $H_0 \parallel [111]$. The measured anisotropy is discussed. It is shown that the four spin flip transition may be used in special cases to establish continuous wave maser operation by inverting the population of one of the satellite lines. Steady state inversion of one of the nitrogen satellites is incidentally observed in a number of diamonds.

539.2 : 538.27

10225 PARAMAGNETIC RESONANCE LINE FORMS IN D.P.P.H. AT RADIO FREQUENCIES. J.C.Verstelle.
Physica, Vol. 24, Supplement, S159 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Dispersion and absorption measurements have been made on a sample of D.P.P.H. at frequencies ranging from 1 to 20 Mc/s at liquid hydrogen temperatures. The experiments have been made with a twin-T bridge, enabling measurements to be made of both χ' and χ'' simultaneously as functions of a static magnetic field. It was found that the resonance-line could not be described by the Van Vleck–Fröhlich-Weisskopf formulae for a Lorentz-line (Abstr. 5802, 11332 of 1954) nor by formulae corresponding to a Gaussian curve. No satisfactory way of describing the results can be found, unless it is assumed that the τ-value is strongly dependent on the static external field.

539.2 : 538.27

10226 PARAMAGNETIC RESONANCE IN FLUORIDES OF THE ION Gd^{+++} SUBJECTED TO A TETRAGONAL CRYSTAL-LINE FIELD. J.Sierro and R.Lacroix.
C.R.Acad.Sci.(Paris), Vol. 250, No. 15, 2686-7 (April 11, 1960). In French.

Experiments have been carried out at 9200 Mc/s on a single crystal of artificial fluoride containing 0.01% gadolinium. Values were obtained for the matrix elements of the crystalline field and for the separations of the energy levels. Several specimens showed an increase of the number of gadolinium ions on tetragonal sites from 40% to 90% after heat treatment at a 1000°C. This evidence lends support to the interpretation of Baker et al. (Abstr. 13455 of 1959). D.J.Oliver

539.2 : 538.27

10227 MAGNETIC RELAXATION PHENOMENA IN GERMANIUM AT LOW TEMPERATURES.
L.Van Gerven, A.Van Itterbeek and L. de Laet.
Physica, Vol. 24, Supplement, S162 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: By means of an experimental arrangement and the usual methods for magnetic resonance absorption studies, some magnetic relaxation phenomena have been found in pure and doped germanium at low temperatures, using relatively low radiofrequencies (20 to 100 Mc/s). Two different absorption lines have been observed. They differ by their sign and by the temperature region, where they occur. Their properties and possible origins are discussed, using an extension of the so called "modified" Bloch theory of the magnetic resonance phenomenon.

539.2 : 538.27 : 535.33

10228 PARAMAGNETIC RESONANCE AND OPTICAL SPECTRA OF DIVALENT IRON IN CUBIC FIELDS. I. THEORY.
W.Low and M.Weger.
Phys. Rev., Vol. 118, No. 5, 1119-30 (June 1, 1960).

The energy level splittings of the ground state of the d^6 configuration in cubic and axial fields are given. The Zeeman splittings of the various levels are calculated for weak and strong magnetic fields. In the case of tetrahedral symmetry the effect of the perturbations of the odd-parity configurations d^5p and d^5f on the ground state is estimated.

539.2 : 535.33 : 538.27

OPTICAL SPECTRA OF Fe^{2+} IN CUBIC FIELDS.
See Abstr. 10228-9

539.2 : 538.27 : 535.33

10229 PARAMAGNETIC RESONANCE AND OPTICAL SPECTRA OF DIVALENT IRON IN CUBIC FIELDS. II. EXPERIMENTAL RESULTS. W.Low and M.Wager.
Phys. Rev., Vol. 118, No. 5, 1130-6 (June 1, 1960).

The paramagnetic resonance absorption of Fe^{2+} in MgO is observed at $g = 3.428$ and 6.86. The optical absorption line is found at 10 000 cm^{-1}. The paramagnetic resonance spectrum indicates considerable covalent bonding. The origin of the line at 6.86 is discussed. In tetrahedral ZnS a paramagnetic line is found at $g = 2.25$ and optical absorption at 3 μ and 0.7 μ. Possible explanations of this spectrum are discussed. A short discussion of the optical absorption spectra of trivalent iron in MgO is presented.

539.2 : 538.27

10230 THE MAGNETIC SUSCEPTIBILITIES AND THE PARAMAGNETIC RELAXATION OF A $MnCl_2.4H_2O$ SINGLE CRYSTAL. M.A.Lasheen.
Physica, Vol. 24, Supplement, S165 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The magnetic susceptibilities of a $MnCl_2.4H_2O$ single crystal parallel to its c and b crystal axes have been measured in the temperature regions of liquid hydrogen and liquid helium. The susceptibility parallel to the two axes follows a Curie–Weiss law $\chi = C/(T + \Delta)$ with $\Delta = 1.8$°K. The Néel temperature was found to be 1.62°K which agrees with the specific heat determination by Friedberg and Wasscher. A maximum in the susceptibility was found at the Néel temperature both in b- and c-directions, the one in the b-direction being rather sharp. The influence of the external field below the Néel temperature was studied and compared with the predictions of the molecular field theory. Values of the specific heat of the spin system above 2°K are well inversely proportional to T^2. Below that temperature the values are increasing as the temperature approaches the Néel temperature. This is in agreement with the direct specific heat determination. Relaxation times have been studied as functions of the temperature and the magnetic field above the Néel temperature. Below the Néel temperature no relaxations were found and this is probably due to the relaxation time being less than 10^{-4} sec.

539.2 : 538.27

10231 EFFECT OF DEUTERIUM SUBSTITUTION ON THE LIFETIME OF THE PHOSPHORESCENT TRIPLET STATE OF NAPHTHALENE. C.A.Hutchison, Jr and B.W.Mangum.
J. chem. Phys., Vol. 32, No. 4, 1261-2 (April, 1960).

Paramagnetic resonance of the triplet state of naphthalene at 77°K has shown that the lifetime of this state for completely deuterated naphthalene in completely deuterated durene is 16.9 ± 0.7 sec compared with 2.1 ± 0.1 sec for ordinary naphthalene in durene. This is shown to be a mass dependent effect and several possible mechanisms are suggested. J.M.Baker

539.2 : 538.27

10232 SPIN LATTICE RELAXATION IN NEODYMIUM ETHYLSULPHATE AT LIQUID HELIUM TEMPERATURES.
J.M.Daniels and K.E.Rieckhoff.
Canad. J. Phys., Vol. 38, No. 5, 604-15 (May, 1960).

The optical Faraday effect was used to measure instantaneous magnetization in neodymium ethylsulphate. The spin populations were disturbed by pulses of microwave power, and by adiabatic magnetization and demagnetization, and the approach to equilibrium was studied. The relaxation was found to be exponential and spin lattice relaxation times were measured, for temperatures between 1.3°K and 4.2°K, and for magnetic fields between 80 and 6000 Oe. The relaxation time was found to decrease with increasing magnetic field, and to vary with temperature approximately as $1/T^3$. No dependence of relaxation time on pulse length was found.

539.2 : 538.27

10233 PARAMAGNETIC RESONANCE OF Ni^{++}, V^{++}, AND Cr^{+++} IN ZnF_2. M.Peter and J.B.Mock.
Phys. Rev., Vol. 118, No. 1, 137 (April 1, 1960).

The mm-wave paramagnetic resonance spectra of these ions in ZnF_2 were measured. Evidence was found that the extra charge of Cr^3 is compensated by an F^- ion, sitting on one of two available nonequivalent neighbouring sites. The antiferromagnetic resonance line in NiF_2, which has been postulated by Moriya, is now expected to occur at 320 kMc/s.

539.2 : 538.27

10234 PARAMAGNETIC RELAXATION IN NICKEL FLUOSILICATE. W.B.Mims and K.D.Bowers.

Physica, Vol. 24, Supplement, S166 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: A pulsed microwave method has been used to investigate paramagnetic relaxation at liquid helium temperature in crystals of nickel fluosilicate magnetically diluted with zinc fluosilicate. Experiments were made without external quantizing field, and at frequencies near 4 kMc/s corresponding to the zero field splitting. The build-up to a steady value of spin temperature was observed when microwave power was applied; the decay when power is removed deviates markedly from the exponential form required by simple theory. Relaxation has been studied over a range of temperatures from 4.2° K to 1.8° K, and in crystals of different magnetic concentration. The immediate physical environment of the crystal was changed from helium liquid to helium gas without producing any appreciable effect on the relaxation time.

539.2 : 538.27

10235 PARAMAGNETIC RESONANCE IN TETRAVALENT Pa^{231}. J.D.Axe, Ru-tao Kyi and H.J.Stapleton.

J. chem. Phys., Vol. 32, No. 4, 1261 (April, 1960).

Paramagnetic resonance was observed at 4.2° K and 9457 Mc/s in a single crystal of Cs_2ZrCl_6 grown from a melt doped with Pa^{231}. The spectrum was isotropic, comprising four hyperfine lines corresponding to a nuclear spin of 3/2. The parameters of the spin Hamiltonian are $|g| = 1.14 \pm 0.02$ and $|A| = 0.0529 \pm 0.001$ cm^{-1}.

J.M.Baker

539.2 : 538.27

10236 SATURATION AND RECOVERY OF A PORTION OF THE ELECTRON SPIN RESONANCE OF F CENTERS IN KCl AT 4° K. G.A.Noble.

Phys. Rev., Vol. 118, No. 4, 1028-9 (May 15, 1960).

The inhomogeneously broadened magnetic resonance of F-centres in additively coloured potassium chloride was photographed using a field modulation which swept rapidly across the resonance as the absorption was displayed on the oscilloscope. The time between sweeps was long and adjustable. A concentration dependence of the spin lattice relaxation time was observed at 4.2° K. In crystals with a concentration near 1×10^{17} cm^{-3}, a portion of the resonance could be saturated without affecting the rest of the broad spectrum. The recovery time of this "hole burned in the resonance" is about $\frac{1}{4}$ min. The results are compared with present theories on spin diffusion.

539.2 : 538.27 : 535.27

10237 ELECTRON SPIN RESONANCE AND THERMOLUMINESCENCE IN IRRADIATED FUSED QUARTZ.

P.O.Fröman, R.Pettersson and T.Vinngård.

Ark. Fys., Vol. 15, Paper 40, 559-66 (1959).

Fused quartz has been irradiated with neutrons and protons at room temperature and with X-rays and γ-rays at liquid air temperature. The two corpuscular radiations give rise to a narrow electron spin resonance line superimposed on a broader six-line structure, which is tentatively suggested to be due to a hyperfine interaction with impurities of Al^{27}. The samples exposed to the electromagnetic radiations at liquid air temperature show in addition an unstable resonance line, and on heating they emit light. It is found that the electron spin resonance and the thermoluminescence are due to different kinds of centres.

539.2 : 538.27

10238 SPIN RESONANCE OF V^{2+}, V^{3+}, V^{4+} IN α-Al_2O_3. J.Lambe and C.Kikuchi.

Phys. Rev., Vol. 118, No. 1, 71-7 (April 1, 1960).

The electron spin resonance absorption properties of vanadium sapphire are reported. It is shown that normally vanadium is predominantly trivalent with a small amount in the tetravalent state. After X- or gamma irradiation, vanadium is converted to the divalent state. The h.f.s. component separations for V^{2+}, V^{3+}, and V^{4+} are about 88, 110, and 140 G, respectively. Because of its readily recognizable spin resonance signature, due to its nuclear spin and because of the ease of producing different oxidation states, it is suggested that vanadium may be a suitable probe to study ionization effects in certain solids.

539.2 : 538.27

10239 PARAMAGNETIC RESONANCE OF Yb^{+++} IN ALUMINUM AND GALLIUM GARNETS.

J.W.Carson and R.L.White.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 53S-54S (May, 1960).

The paramagnetic resonance spectrum of Yb^{+++} in gallium and aluminium garnets has been observed at liquid nitrogen and helium temperatures. The components of the principal g tensor are 2.85, 3.60, and 3.74 in gallium garnet, and 2.47, 3.78 and 3.87 in aluminium garnet. In aluminium garnet, for a range of Yb concentrations (relative to Y) of from 2% to 0.1%, the line width varies linearly from 98 to 20 G. The longitudinal relaxation time T_1, for the same Yb variation, increases from 0.001 to 0.02 sec.

539.2 : 538.27

10240 SPIN RESONANCE OF CHARGE CARRIERS IN GRAPHITE. G.Wagoner.

Phys. Rev., Vol. 118, No. 3, 647-53 (May 1, 1960).

The observations reported here of the electron spin resonance in quite perfect single crystals of graphite clearly establish that the resonance arises from mobile charge carriers. The line shape is of the Dysonian form which is charcteristic of conduction electron spin resonance in metals. The intensity of the spin resonance agrees, both in absolute magnitude and in temperature dependence, with values calculated from the band model of graphite by McClure. The g value of the resonance shows a remarkably large anisotropy which depends strongly on temperature and on the position of the Fermi level with respect to the band edge. At room temperature in pure graphite, g varies from 2.0026 ± 0.0002 to 2.0495 ± 0.0002 as the magnetic field is shifted from perpendicular to parallel to the c-axis. The g-value anisotropy increases with decreasing temperature; $g_\parallel$ becomes 2.127 at 77° K while $g_\perp$ remains constant. The line-width of the resonance is a few gauss ($T_2 = 2.0 \times 10^{-8}$ sec) which is extremely narrow in comparison with the field shifts caused by changes of anisotropy with temperature. This indicates that for conduction states in graphite, the $g_\parallel$ value is a strong function of the wave vector and that the line is narrowed by an averaging process in k space. This averaging is similar to that which occurs in motional and exchange narrowing.

539.2 : 538.27 : 537.311

10241 IMPURITY SPIN RELAXATION VIA THE CONDUCTION ELECTRONS IN SILICON. A.Honig.

Physica, Vol. 24, Supplement, S163 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The impurity electron spin relaxation time in phosphorus doped silicon has been measured as a function of incident infrared radiation power having a room temperature black body spectral distribution. This relaxation is presumably brought about by the conduction electrons which are produced by photoionization of the impurity atoms. Of several existing interaction mechanisms the spin-exchange mechanism given by Pines, Bardeen and Slichter (Abstr. 5727 of 1957) yields the largest relaxation rate. For an incident infrared power of 4×10^{-9} W, the bound electron spin relaxation time was reduced from 15 minutes (zero infrared radiation power) to 4 minutes. Assuming a photon absorption probability of unity, one obtains the $\sim 10^6$/cm^3 conduction electron concentration required by the spin exchange mechanism for a 4 minute relaxation time if the conduction electron lifetime against trapping is about 0.5 microsecond. This trapping lifetime appears reasonable, though no direct measurements have yet been made. It has also been found that the relaxation rate is proportional to the incident infrared power, and hence to the concentration of conduction electrons.

539.2 : 538.27

10242 ELECTRON NUCLEAR DOUBLE RESONANCE (ENDOR) EXPERIMENTS. G.Feher.

Physica, Vol. 24, Supplement, S80-S87 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Nuclear polarization by the double resonance (electronic transition followed by nuclear transition) method is described; its various applications to nuclear and to solid-state physics are surveyed.

L.Mackinnon

539.2 : 538.27

10243 PARTICLE-SIZE EFFECT ON NUCLEAR SPIN–LATTICE RELAXATION TIME.

D.A.Jennings and W.H.Tantilla.

Physica, Vol. 24, Supplement, S158 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The spin lattice relaxation time of iodine nuclei in potassium iodide has been measured at 4.2°K. The potassium iodide was highly doped with paramagnetic copper. The measurements were made as a function of particle size. The relaxation time increased slowly as the particle size diminished. However, in going from particles 0.335 mm in diameter to particles 0.188 mm in diameter, the relaxation time changed from 30 seconds to 22 minutes. For particles smaller than 0.188 mm the relaxation time increased again rather slowly as the particle size diminished. These results are interpreted as being due to the elimination of direct process relaxation, as the boundary conditions of the smaller particles eliminate the modes responsible for the direct process relaxation. The direct process relaxation from paramagnetic ions is greatly enhanced due to the discontinuity in mass that a lattice wave encounters at a paramagnetic ion. This enhancement is destroyed by grinding the particles to a smaller size.

539.2 : 538.27

10244 CONTRIBUTION TO THE THEORY OF SPIN–LATTICE RELAXATION OF NUCLEAR SPINS IN IONIC CRYSTALS.

B.I.Kochelaev.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 242-8 (July, 1959).

In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 1, 171-5 (Jan., 1960).

Examined theoretically (for room temperature) taking account of the optical vibrations of the crystal lattice. Numerical calculations are made for NaCl-type lattices. The agreement with experimental results is satisfactory.

539.2 : 538.27

10245 NUCLEAR MAGNETIC RESONANCE IN CERIUM ETHYLSULFATE AT TEMPERATURES BELOW 1°K.

J.C.Wheatley and A.C.Anderson.

Physica, Vol. 24, Supplement, S156 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: Recent work on cerium ethyl sulphate at temperatures below 1°K has indicated that a cooperative magnetic transition occurs in zero external field for entropies less than $S/R = 0.45$ (Abstr. 8084 of 1955). Nuclear resonance studies on the protons in this salt should be useful in determining an S–T relation and in investigating the exact nature of the cooperative transition. The crystal was mounted so that the plane of rotation of the strong field would include the hexagonal crystal axis. The crystal was cooled by partial demagnetization to the resonance field followed by adiabatic rotation until the strong field was perpendicular to the hexagonal axis. Temperatures were obtained by measuring the area under the absorption curves. Resonance fields of 1615 G and 2370 G were used. It was found that the interionic interaction entropy is $ST^3/R = 3.1 \times 10^{-4}$ deg^3 down to $S/R = 0.44$, with only small deviations from the $1/T^3$ law at $S/R = 0.35$. The cerium magnetization as deduced from the resonance structure was found to be proportional to $\tanh g_{\perp} \beta H/2kT$ down to $S/R = 0.35$ with no evidence for a cooperative transition.

539.2 : 538.27

10246 NUCLEAR RESONANCE IN FERROMAGNETIC COBALT.

A.M.Portis and A.C.Gossard.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 205S-213S (May, 1960).

The observation of nuclear magnetic resonance in ferromagnetic cobalt is reported. The resonance frequency for finely divided face-centred-cubic material has been measured in the intermediate temperature range. The frequency extrapolated to 0°K is 217.2 Mc/s, and the temperature dependence in this range is in general agreement with that of the magnetization. This frequency implies a hyperfine field of 217 500 Oe, which is in good agreement with the field deduced from specific heat measurements on hexagonal cobalt. The agreement in the two structures indicates that there is no dipolar contribution to the hyperfine field. The theoretical implications of this observation are discussed. The resonance line is inhomogeneously broadened with a half width of 400 kc/s. A pattern of beats is observed at high passage rates which makes it possible to determine a spin–spin time of 25 μsec. By varying the modulation frequency under conditions of intermediate saturation the spin lattice relaxation time is measured to be 280 μsec. The resonance signal is remarkably intense, being 5×10^3 stronger than calculated for a dipole transition in the driving radio frequency field. It is shown from the saturation measurements that the r.f. field at the cobalt nucleus is 10^3 times stronger than the external driving field. These intensity and saturation measurements, as well as the observed line shape, establish that the resonance is driven by domain wall motion. Only those spins within the domain walls are affected. An external field reduces the intensity of the resonance but produces no shift in the resonance frequency. Both these effects are consistent with domain wall excitation. Spin–spin relaxation is interpreted as a spin wave coupling reduced in intensity by the broadening of the resonance spectrum. The spin–lattice relaxation is by spin diffusion away from the domain walls and ultimately to the lattice by coupling with the conduction electrons as suggested by the temperature dependence of the relaxation time.

539.2 : 538.27

10247 NUCLEAR MAGNETIC RESONANCE IN DILUTED Cu–Mn ALLOYS. W.Van der Lugt and N.J.Poulis.

Physica, Vol. 24, Supplement, S158 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The shape of the Cu^{63} nuclear magnetic resonance line in Cu metal proves to depend strongly on very small amounts of paramagnetic impurities (e.g. Mn). The line width Δ, defined as the distance in field strength between the two points of maximum slope of the absorption curve, which is about 6.6 Oe in pure copper, is broadened by an appreciable factor, which depends on temperature, Mn concentration and the d.c. field strength H_0. Δ proved to increase with increasing concentration and d.c. field strength and with decreasing temperature, amounting to $\Delta = 85$ Oe for 0.06% Mn and $H_0 = 8500$ Oe at 1.25°K. Three samples were investigated: 0.01% Mn, 0.03% Mn and 0.06% Mn, in the temperature range from 1 to 90°K, and in fields from 1770 Oe to 8500 Oe. The measurements were performed with a Pound–Watkins oscillator and a lock-in amplifier.

539.2 : 538.27

10248 NUCLEAR MAGNETIC RESONANCE IN PARAMAGNETIC FeF_2. J.W.Stout and R.G.Shulman.

Phys. Rev., Vol. 118, No. 5, 1136-41 (June 1, 1960).

For previous work, see Abstr. 6458 (1957); 7322 (1958); 1590 (1959). A study of the F^{19} resonance is reported. The hyperfine interactions with the magnetic electrons were measured and shown to be important in determining the resonance properties. The isotropic hyperfine interaction indicates the presence of (0.46 ± 0.03)% unpaired 2s spins in F^- orbitals from each Fe^{2+} ion neighbour.

539.2 : 538.27

10249 NUCLEAR MAGNETIC RESONANCE IN ANTIFERROMAGNETIC MnF_2 UNDER HYDROSTATIC PRESSURE.

G.B.Benedek and T.Kushida.

Phys. Rev., Vol. 118, No. 1, 46-57 (April 1, 1960).

The nuclear magnetic resonance frequency of the F^{19} nucleus in antiferromagnetic MnF_2, in zero external field, was measured as a function of pressure at 4.2°, 20.4° and 35.7°K using a new type very-high-frequency, variable-frequency spectrometer. From these measurements the authors deduced the pressure dependence of the hyperfine coupling constant (A) between the manganese electrons and the fluorine nucleus, and the pressure dependence of the Néel temperature. This deduction gives

$$(1/A)(dA/dP) = +(1.9 \pm 0.1) \times 10^{-6}/(kg/cm^2)$$

and

$$(1/T_N)(dT_N/dP) = +(4.4 \pm 0.3) \times 10^{-6}/(kg/cm^2).$$

The compressibility of MnF_2 was also measured. The magnitude and pressure dependence of A is explained using the theories of Mukherji and Das, and Marshall and Stuart, which permit a calculation of the dependence of A on the interatomic distances, starting from the Hartree–Fock self-consistent field wave-functions for Mn^{2+} and F^- with the Mn^{2+} wave-functions properly adjusted to bring it into agreement with neutrons scattering form factor measurements. The theory is in very good agreement with the experimental results.

539.2 : 538.27

10250 PHASE TRANSITIONS IN ANTIFERROMAGNETIC $MnCl_2.4H_2O$. N.J.Poulis and H.M.Gijsman.

Physica, Vol. 24, Supplement, S156-S157 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960. Brief note, substantially as follows: Investigations on the phase

transitions between the two antiferromagnetic states and the paramagnetic one of $MnCl_2.4H_2O$ were performed. Nuclear magnetic resonance studies for the case when the external field H is along the preferred c-axis, gave a set of curves for the transition from the paramagnetic state into the antiferromagnetic state. Electron resonance at low frequencies was used to measure the threshold field as a function of temperature. Magnetization measurements along the c-axis showed a shift of the maxima in magnetization v. temperature curves as a function of H in accordance with the nuclear magnetic resonance experiments, mentioned above. The threshold field values, obtained from the jump in the magnetization, when plotted as a function of H, also fitted very well into this picture. The curve for H parallel to the b axis gave only one transition line. Hartmans made some preliminary specific heat measurements with a powdered sample at several field values. His results lead to a value of the transition temperature about equal to the average of the values obtained here for the three axes. The transition curves for both directions of H are in reasonable agreement with the result of the calculations of Gorter and Van Peski (Abstr. 5209 of 1956).

539.2 : 538.27

10251 THE NUCLEAR RESONANCE RELAXATION AND LINE WIDTH IN THE ANTIFERROMAGNET.

T.Moriya and T.Nakamura.

Physica, Vol. 24, Supplement, S157 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief note, substantially as follows: The anisotropy of the relaxation time of the proton resonance in copper chloride dihydrate recently observed by Hardeman and others can be accounted for by theory presented in Abstr. 7207-8 (1957). The assumption made by Hardeman et al. that the neighbouring electron spins fluctuate with the same phase cannot be justified; rather, the relaxation occurs by the process of the Raman scatterings of the spin waves. The width of the resonance line at low temperatures can result from the indirect coupling between nuclear spins via the spin waves, as via the conduction electrons in the case of metals, and it can be quite large for the nuclei of the atoms with a magnetic moment (600 Oe for Mn and 14 Oe for F in MnF_2).

539.2 : 538.27

10252 PROTON MAGNETIC RESONANCE IN A SERIES OF DIMETHYL SILOXANE POLYMERS. A SPECIFIC LONG-CHAIN EFFECT? J.G.Powles and A.Hartland.

Nature (London), Vol. 186, 26-8 (April 2, 1960).

Proton magnetic relaxation times, T_1 and T_2, are reported for a polydimethyl siloxane grease over a wide temperature range and at 25°C for a series of polymers having a range of molecular weights. There is a fairly sharp melting point, the crystallinity below the melting point is high, and multiple T_2's are observed in the liquid. The results are interpreted in terms of interchain magnetic interactions. It is suggested that the results indicated a critical chain length (1000 atoms) above which characteristic polymer properties are observed, as for viscosity. J.G.Powles

539.2 : 538.27

10253 NUCLEAR QUADRUPOLE SPIN–LATTICE RELAXATION IN ALKALI HALIDES.

E.G.Wikner, W.E.Blumberg and E.L.Hahn.

Phys. Rev., Vol. 118, No. 3, 631-9 (May 1, 1960).

Nuclear quadrupole spin–lattice relaxation times were measured in alkali halide crystals by the pulsed magnetic resonance technique. Measurements were made on Na^{23} in NaCl, NaBr, and NaI; Cl^{35} in NaCl and KCl; $Br^{79,81}$ in NaBr, KBr, RbBr, and CsBr; Rb^{87} in RbCl and RbBr; and I^{127} in NaI, KI, and CsI. Over a temperature range of 298° to 195°K the relaxation times are inversely proportional to the square of the absolute temperature. The data are compared to relaxation times calculated from an ionic crystal model of Van Kranendonk (Abstr. 2300 of 1955) and a covalent model of Yosida and Moriya (Abstr. 1444 of 1956). The ionic model is modified to include the interaction between the nuclear quadrupole moment and the electric field gradient due to electric dipole moments associated with optical modes of vibration. Neither of these models alone predicts the experimental relaxation times for all cases, but a combination of the two effects is required. The modified ionic model applies reasonably well to crystals which contain the lighter ions.

539.2 : 538.27 : 538.56

NUCLEAR QUADRUPOLE COUPLING INTERACTIONS OF K, Cs, AND Rb ISOTOPES IN THEIR CHLORATES. See Abstr. 9226

MECHANICAL PROPERTIES OF SOLIDS

539.3

10254 MEASUREMENT OF SURFACE STRESS IN AUSTENITIC STEEL. J.C.Moore.

Brit. J. appl. Phys., Vol. 11, No. 6, 242-4 (June, 1960).

A method is described to evaluate macro surface stresses in an austenitic steel. A multi-exposure, X-ray back-reflection technique is employed, and surface-stress values obtained by this method are compared with theoretical values.

539.3

10255 DETERMINATION OF THE ELASTIC MODULI OF TIN SINGLE CRYSTALS, AND THEIR VARIATION WITH TEMPERATURE. D.G.House and E.V.Vernon.

Brit. J. appl. Phys., Vol. 11, No. 6, 254-9 (June, 1960).

An apparatus is described for the measurement of the frequencies of resonance of longitudinal and torsional vibrations of circular cylindrical rods at temperatures in the range −180 to +190°C. The values obtained have been used to determine the elastic moduli of single crystals of tin over this range of temperature. The equations relating the elastic moduli to these frequencies of resonance for tetragonal crystal symmetry are given. The values of the elastic moduli at 15°C are given as S_{11} = 41.6, S_{33} = 14.9, S_{44} = 45.6, S_{66} = 42.8, S_{12} = −31.2 and S_{13} = −4.8 in units of 10^{-13} cm^2 dyn^{-1}.

539.3 : 539.2 : 538.2

10256 INTERNAL FRICTION ANOMALIES IN FERROMAGNETS AND ANTIFERROMAGNETS NEAR THE CURIE POINT. K.P.Belov, G.I.Katayev and R.Z.Levitin.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 153S-156S (May, 1960).

Measurements of the temperature dependence of internal friction in a number of ferromagnets and antiferromagnets were carried out. In ferromagnetic alloys (invars) and antiferromagnets (MnO, etc.), which have a large spontaneous deformation of the crystalline lattice near the Curie point, sharp peaks of the internal friction were found. The thermodynamical theory of second order phase transitions is used to interpret this phenomenon.

539.3

10257 BEAM METHOD FOR THE MEASUREMENT OF INTERNAL FRICTION. J.E.Thompson.

J. sci. Instrum., Vol. 37, No. 6, 208-10 (June, 1960).

The oscillatory motion of a swinging beam used to measure the internal friction of a silicon–iron strip has been found to be complicated, and to consist of a small amplitude, higher frequency oscillation superimposed on the main oscillation, so that difficulty arises in obtaining a unique value for the logarithmic decrement of the strip oscillation. The motion has been analysed and reasonable agreement is found between the experimental results and the theory developed.

539.3

10258 LOW-TEMPERATURE INTERNAL FRICTION IN FACE-CENTERED CUBIC AND BODY-CENTERED CUBIC METALS. L.J.Bruner.

Phys. Rev., Vol. 118, No. 2, 399-410 (April 15, 1960).

Data on the anelasticity produced by plastic deformation in various face-centred cubic and bond-centred cubic pure metals and alloys are reported. F.C.C. materials studied at temperatures from 4.2° to 300°K include, Cu, Al, and Al-0.25 at.% Cu. B.C.C. systems are Fe, Nb, and β-brass. Bordoni peaks are observed in Cu and Al in agreement with previous work, but are not found in either strain aged Al–Cu alloys or pure Fe. A peak observed in Nb at 173°K is not believed to be a Bordoni type. Unexplained low-temperature internal friction peaks are also observed in β-brass. A new mechanism is proposed for dislocation relaxation in which the essential feature is the thermally activated motion of paired partial dislocations between vacancy pinning points. It is in general qualitative accord with experiment, and permits semiquantitative evaluation of all essential parameters.

539.3

10259 INTERNAL FRICTION IN SYNTHETIC QUARTZ. C.S.Brown.

Proc. Phys. Soc., Vol. 75, Pt 3, 459-60 (March, 1960).

An examination of samples of synthetic quartz, grown on different seed orientations by different processes, suggests that the internal

friction for a given growth rate is almost unaffected by the growth process, but that it is greatly affected by the growth rate, as is shown in a curve depicting Q measurements made with AT-cut contoured vibrators operating at 5 Mc/s. At the usual growth rates, the Q-factor of synthetic quartz is about 10 times that of natural quartz, but when the growth rate is less than about 0.15 mm/day, the Q-factor of the synthetic crystals approaches that of the natural quartz, i.e. about 3×10^6. H.J.H.Starks

539.3

10260 INFLUENCE OF THE DEFORMATION MECHANISM ON THE RECRYSTALLIZATION OF COLD-WORKED α-URANIUM MONOCRYSTALS.

D.Calais, P.Lacombe and N.Simenel.

J. nuclear Mater., Vol. 1, No. 4, 325-44 (Dec., 1959). In French.

Imperfect α-uranium single crystals, prepared by phase transformation, were extended by 2-15%. Different deformation modes were observed, according to the crystal orientation; the combinations included deformation bands accompanied by slip, slip with some twinning, or predominantly twinning. Which of these deformation modes operated in a crystal of given orientation was determined. These extended samples were annealed at a high temperature within the α range, and underwent either recovery or recrystallization, according to the initial orientation and the extension. The critical extension was found which, for a given orientation and deformation mode, favoured the formation of large recrystallized grains. It appears, according to this study, that deformation by slip or by predominant twinning is the most favourable for producing large perfect crystals of α-uranium. Annealing of crystals which had deformed by the creation of deformation bands, on the other hand, generated numerous narrow and elongated grains of closely similar orientations, which did not coalesce with each other. The conclusion is drawn that slip, with predominant twinning, is the ideal mode of deformation for growing large perfect crystals.

539.3

10261 SOLUTION-PRECIPITATION DEFORMATION UNDER AN APPLIED STRESS. W.D.Kingery and M.P.Lepie.

J. appl. Phys., Vol. 31, No. 3, 610 (March, 1960).

An experiment reminiscent of cutting through an ice block with a loaded wire is described. The solid however is a sodium chloride crystal and it is deformed by a hardness tester. It is found that the deformed area increases with time if there is a little saturated sodium chloride solution at the pressure point, but not if the crystal is perfectly dry. The effect is thus caused by an increase of solubility due to the high compressive stress. D.Walsh

539.3

10262 THE DUCTILITY OF NaCl CRYSTALS. R.G.Greenler and W.S.Rothwell.

J. appl. Phys., Vol. 31, No. 3, 616-17 (March, 1960).

In studying the effect of various treatments on the brittle–ductile behaviour of crystals, samples which have had special treatments are compared with those which have not. Uncontrolled random variations in stress history can produce effects of much greater magnitude than those attributed to other causes. In flexural tests on single crystals of salt, for example, beams supported on rollers which can rotate give different results from those supported on knife edges. The strains introduced into single crystals of salt by cleavage, surface damage in handling, measurements by micrometer, or light scratching of the surface, can affect the results. Ductility was greater by a whole order of magnitude in specimens not measured with a micrometer prior to bending. A batch of crystals was cleaved to have $\frac{1}{4}$ in. square sections, reduced to $\frac{1}{5}$ in. square by dissolving in water, and then loaded to twice their yield stress and unloaded. Only those which had yielded more than 1.8% were selected for further tests, and these were loaded with various orientations of the square section. Differences occurred indicating that the method of preparation was of value. A.C.Whiffin

539.3

10263 ON THE MICROSTRESSES ARISING IN METALS UNDER PLASTIC DEFORMATION. II. D.M.Vasil'ev.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1736-46 (Nov., 1959). In Russian.

For Pt I, see Abstr. 10315 of 1959. Plots of X-ray results are given illustrating oriented residual deformations in metals after macroscopically uniform plastic deformation. These imply oriented residual stresses in the "matrix" (in the sense of regions contributing coherent X-ray reflections to lines of the matrix phase), with counterstresses therefore confined to regions either of precipitate phase, or of small dimensions or incoherent structure. Steel, iron, Al, Ni, Cu and Mo all gave compressive microstresses; the sign of the preceding deformation was reflected only in the ratio of transverse to longitudinal components. (After extension the latter were greater in magnitude, after compression the former). Cementite inclusions did show counterstresses, but of insufficient magnitude to complete the internal equilibrium. It is concluded that grain or mosaic boundaries must take part. I.D.C.Gurney

539.3

10264 ON THE ROLE OF MICROSTRESSES IN THE PROCESS OF PLASTIC DEFORMATION OF METALS.

D.M.Vasil'ev and G.I.Arkovenko.

Fiz. tverdogo Tela, Vol. 2, No. 3, 543-6 (March, 1960). In Russian.

The effect of microstresses, induced by preliminary straining and measured by X-ray diffraction technique, on the resistance to deformation of homogenized L-70 brass and annealed Al specimens was studied by means of hardness measurements and determination of the 0.05% proof stress. The experimental results are discussed in terms of different mechanical properties of the A- and B-regions (the interior of the grains and the grain boundary layers, respectively). M.H.Sloboda

539.3

10265 A THEORETICAL ANALYSIS OF THE MECHANICAL RELAXATION OF SINGLE-CRYSTALLINE ICE.

R.Bass.

Proc. Roy. Soc. A, Vol. 247, 462-4 (Oct. 21, 1958).

Two relaxation mechanisms are considered: (1) disturbance of equilibrium between a large number of possible hydrogen arrangements by mechanical deformation of the lattice, and (2) redistribution of lattice defects such as doubly occupied and vacant bonds between neighbouring oxygen atoms. Calculations show that mechanism (1) is consistent with experimental results, whereas mechanism (2) is not. R.F.S.Hearmon

539.3 : 539.2 : 548.7

ELECTRON DIFFRACTION STUDY OF PROGRESSIVE LATTICE DISTORTION IN STRESSED CRYSTAL LAMELLAE.

539.3 : 539.214

10266 STUDY OF VISCOUS FLOW OF RUBBERS. I. METHOD OF CONSTANT DEFORMATION.

I.P.Korol'.

Zh. tekh. Fiz., Vol. 29, No. 4, 471-9 (April, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 420-7 (April, 1959).

Cylindrical specimens of rubber annealed at 100°C were rapidly compressed longitudinally and then held at constant deformation. The variation of the amount of subsequent elastic recovery with the duration of the controlled deformation is interpreted in terms of a four-constant rheological model. In the case of polyisobutylene an empirical equation is proposed relating molecular weight, temperature and degree of compression with a characteristic time, defined as the time at constant deformation after which one-half of the deformation is recoverable. J.G.Oldroyd

539.3 : 539.214

10267 STUDY OF VISCOUS FLOW OF RUBBERS. II. FLOW OF RUBBERS DURING CONSTANT DEFORMATION.

I.P.Korol'.

Zh. tekh. Fiz., Vol. 29, No. 4, 480-6 (April, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 428-33 (April, 1959).

See preceding abstract. The work is extended to natural rubber and some synthetic rubbers. J.G Oldroyd

539.3 : 539.214

10268 STUDY OF VISCOUS FLOW OF RUBBERS. III. FLOW OF CONCENTRATED SOLUTIONS OF SOME RUBBERS.

I.P.Korol'.

Zh. tekh. Fiz., Vol. 29, No. 4, 487-90 (April, 1959). In Russian.
English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 4, 434-7 (April, 1959).

The effect of molecular weight on the flow of solid rubbers (see two preceding abstracts) is compared with the effect of molecular weight on the viscosity of rubber solutions. J.G.Oldroyd

539.3 : 539.214

10269 STUDY OF VISCOUS FLOW OF RUBBERS. IV. FLOW OF NATURAL RUBBER AND POLYISOBUTYLENE AS FUNCTION OF THE MOLECULAR COMPOSITION. I.P.Korol'.
Zh. tekh. Fiz., Vol. 29, No. 5, 647-52 (May, 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 5, 577-81 (Nov., 1959).

Experimental data are presented. The flow was studied by the method of constant deformation. It is shown that under these conditions the fluidity of rubbers is determined by a quantity, called the characteristic-viscosity averaged molecular weight, given by

$$M_{\eta} = \sum_i w_i [\eta]_i M_i / \sum_i w_i [\eta]_i ,$$

where i, w, $[\eta]$, and M are, respectively, the order number, weight fraction, characteristic viscosity and molecular weight of the i-th fraction of the polymer. Consideration is also given to the problem of the effect of the molecular composition on the properties of polymers.

539.3

10270 MODIFICATION OF A PICKUP FOR MEASURING THE DYNAMIC VISCOUS-ELASTIC PARAMETERS OF SYNTHETIC RUBBER. V.A.Kuznetsov.
Akust. Zh., Vol. 5, No. 3, 371-2 (1959). In Russian. English translation in: Soviet Physics – Acoustics (New York), Vol. 5, No. 3, 379-80 (Feb., 1960).

A modification of the type of pickup (piezoelectric element) used by Nolle was used to measure the dynamic Young's modulus and the dynamic viscosity coefficient of synthetic rubber. The velocity and attenuation of longitudinal travelling waves in the frequency range 1-3.5 kc/s were measured using the pickup and the dynamic viscous-elastic parameters were calculated from Nolle's equation. The measurements were made on divinylstyrene synthetic rubber SKS-30A (nonvulcanized, non-plasticized). C.F.Barnaby

539.3 : 532.5

ANALOGY BETWEEN THE SLOW MOTION OF A VISCOUS FLUID AND THE EXTENSION AND FLEXURE OF PLATES: A GEOMETRIC DEMONSTRATION BY MEANS OF MOIRÉ FRINGES.
See Abstr. 8603

539.4

10271 THE TENSILE PROPERTIES OF IRRADIATED URANIUM. D.Shaw.
Nuclear Engng, Vol. 5, 214 (May, 1960).

It is found that irradiation up to a burn-up of about 1000 MWd/tonne does not cause a progressive deterioriation of tensile strength. Embrittlement occurs at an early stage, however, the ductility being negligible even after a burn-up of 200 MWd/tonne. Thermal cycling produces a loss of tensile strength, which is considered to be due to the formation of intergranular cracks. J.Thewlis

539.4

10272 THE STRENGTH OF SOLIDS. S.N.Schurkow.
Z. phys. Chem. (Leipzig), Vol. 213, No. 3-4, 183-90 (1960). In German.

From experiments in which the duration of loading varied over 8 orders of magnitude, a relation is proposed relating the ultimate strength to the temperature and the duration of loading. An activation energy and a time constant are obtained. These are compared, for some metals, with the energy to evaporate an atom and with the periodic time of the atom's lattice vibration.
J.E.Caffyn

539.4

10273 THE APPEARANCE OF SURFACE CRACKS IN POLYVINYL CHLORIDE UNDER TENSION. J.C.Bauwens and G.A.Homès.
C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2203-5 (March 21, 1960). In French.

Surface cracks were observed in 1 mm thick specimens of polyvinyl chloride on stretching. The cracks ceased to grow on reaching a length of about 0.1 mm. The authors explain the propagation of the cracks by Griffith's theory (Abstr. 1352 of 1921) and suggest that they cease to grow when plastic deformation of their extremities becomes necessary. R.G.C.Arridge

539.5

10274 SURFACE CRACKS ON GLASS. A.S.Argon.
Proc. Roy. Soc. A, Vol. 250, 472-81 (April 7, 1959).

The sodium vapour etching experiments of Andrade and Tsien (1937) were repeated with chemical Pyrex glass. By employing a ball indenter in conjunction with the vapour etching, it was possible to determine with greater accuracy the real nature of the surface cracks that were developed. Thereby, it was established that the surface stressing action of the sodium vapour not only dilates the existing cracks, but also forms additional extensive networks. Furthermore, the ball indenter is capable of distinguishing the real from the artificial cracks. Glasses other than chemical Pyrex were found resistant to etching.

539.5

10275 DISTRIBUTION OF CRACKS ON GLASS SURFACES. A.S.Argon.
Proc. Roy. Soc. A, Vol. 250, 462-92 (April 7, 1959).

The ball indentation experiment was used to determine the density distributions of surface cracks of various severities on flat glass plates. The fracture load histograms that result from a large number of indentations with a ball indenter are the basis of the information on the distribution of cracks. The integral equation relating the probabilities of fracture as a function of load to the crack distribution function was solved with an operational inversion by means of the two-sided Laplace transform. The distributions of cracks were calculated for a chemical Pyrex glass and for a window glass.

539.6

10276 ACTION OF GRAPHITE AS A LUBRICANT. W.Bollmann and J.Spreadborough.
Nature (London), Vol. 186, 29-30 (April 2, 1960).

Electron microscopic observation of graphite flakes prepared by rubbing on to supporting grid shows a rolling up of thin sheets. The plain or spiralled rolls have external diameter 0.1 - 1μ and the thickness of the sheet is estimated to be about 100 atomic planes. A "roller bearing" mechanism is suggested to explain the lubricating properties of graphite, which is said to be consistent with effect of temperature and various vapours on friction of graphite.
J.W.Menter

539.6

10277 THE DEPENDENCE OF FRICTION ON SURFACE ROUGHNESS. P.V.K.Porgess and H.Wilman.
Proc. Roy. Soc. A, Vol. 252, 35-44 (July 7, 1959).

The variation of the coefficient of friction (0.57 to 0.66) with surface roughness is investigated experimentally in the case of emery paper sliding on various grades of emery paper. It is established that the main variable part of the friction is a function of the ratio of the radii of the emery particles in the two surfaces, and is a minimum when the radii are equal. Theoretically it is shown that the work done in the repeated up-and-down motion of the smaller particles against the elastic backing, as they slide over the larger particles in the opposing sheet, accounts well for the form and magnitude of this friction component, the fraction of the energy lost in the hysteresis being 0.6. The remaining practically constant part of the friction is then 0.42, which is appreciably larger than the friction of sapphire on sapphire, 0.2, but is not far from the value 0.36 determined experimentally for a chip of mineral emery sliding on a smoothed surface prepared on a fresh fracture of the mineral.

539.8

10278 DISTORTION AND RUPTURE IN THE SURFACE LAYER OF LITHIUM FLUORIDE CRYSTALS. Ya. E.Geguzin and A.A.Shpunt.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 4, 755-7 (Feb. 1, 1960). In Russian.

The surface of LiF crystals was marked by scratching with diamond points of varying profile, with steel cones of differing angle, and by milling. The distribution of dislocations, revealed by subsequent etching, is discussed in relation to the width of the scratch, the form of the indentor, the velocity of scratching, and other factors. R.F.S.Hearmon

CRYSTALLOGRAPHY
CRYSTAL STRUCTURES

539.2 : 548.5

10279 CRYSTAL NUCLEUS OBSERVATIONS IN AQUEOUS KBr AND NaCl SOLUTIONS. Z. Gyulai.

Acta phys. Hungar., Vol. 10, No. 4, 371-88 (1959). In German.

A detailed description with photographs of visual and photographic observations of the types of crystal formed in solutions cooled at different rates. Slow cooling produces a small number of nuclei. Strong movement or shaking of the supersaturated solution produces an avalanche of nuclei with the formation of needle and lamina type crystals, which when suitably illuminated exhibit coloured interference patterns. The needle type crystals are mostly of spiral form and are examples of the Frank-Read growth mechanism. The occurrence of the avalanche indicates an unstable condition of the solution, and this is explained.

S.Weintroub

539.2 : 548.5

10280 PRESSURE SOLUTION AND THE FORCE OF CRYSTALLIZATION—A PHENOMENOLOGICAL THEORY. P.K.Weyl.

J. geophys. Res., Vol. 64, No. 11, 2001-25 (Nov., 1959).

The phenomena of pressure solution and the force of crystallization result from removal or deposition of mineral matter in the region of contact between the mineral grains. Assuming that this transport takes place by diffusion in a solution film between the grains the rate of transport depends on the grain size, the effective normal stress between the grains, the diffusion constant in the solution film, the film thickness, and the stress coefficient of solubility. Values of these parameters required to obtain the amount of pressure solution observed in the St. Peter sandstone are reasonable. The theory predicts an increase in pressure solution with decreasing grain size. The effect of clay films between the grains is also to increase the rate of pressure solution owing to the more rapid rate of diffusion in the clay layer relative to a single solution film between clean mineral grains. This explains how pre-existing clay films in the sediment may, because of the greater rate of pressure solution, develop into stylolites. If the interstitial water is supersaturated with respect to the minerals present, precipitation in the area of contact will take place as long as the supersaturation divided by the stress coefficient of solubility is greater than the average effective normal stress between the grains. If the stress is increased above this limit, pressure solution will take place.

539.2 : 548.5

10281 THE PROPERTIES AND BEHAVIOUR OF SOME ARTIFICIAL ICE NUCLEI. B.J.Mason and A.P.van den Heuvel.

Proc. Phys. Soc., Vol. 74, Pt 6, 744-55 (Dec., 1959).

Reasons for the discordant results obtained by different workers on the ice-nucleating properties of chemical aerosols are discussed and, in an attempt to resolve these differences, the ability of a variety of pure, inorganic crystals to nucleate supercooled water clouds in both diffusion- and mixing-cloud chambers, and also large drops of highly purified water, has been carefully investigated. For a finely dispersed, insoluble substance, closely similar threshold nucleation temperatures were obtained with all three techniques. The results for finely powdered metallic oxides were less reproducible and were peculiar in that the activity of the particles, always slight, did not increase markedly as the temperature was lowered below the threshold value. Also, their potency was reduced by wetting of their surfaces. A number of substances, e.g. CdI_2, NH_4F and I_2, normally inactive in a water cloud because of their solubility, initiate ice-crystal formation in an atmosphere sub-saturated relative to water but supersaturated relative to ice. Insoluble nuclei may act as either "freezing" or "sublimation" nuclei depending on the temperature. Thus silver iodide nuclei act between -4°C and -12°C only if the air surpasses water saturation but, at lower temperatures, they act as sublimation nuclei provided the supersaturation relative to ice exceeds 12%; lead iodide shows a similar behaviour but requires a critical supersaturation of 15% below -15°C. The efficiency of ice-forming nuclei may be interpreted partly, but not wholly, in terms of the particles possessing low-index crystals faces in which the atomic spacings differ from those in either the basal or prism faces of ice by not more than a few per cent. That such geometrical considerations alone are insufficient becomes apparent from experiments in which epitaxial deposits of ice crystals have been formed on large, single crystals of seven different substances.

539.2 : 548.5 : 537.311

10282 CONTRIBUTION TO THE CRYSTALLIZATION PROCESS OF Se. D.J.Fourie and C.M.van der Walt.

Z. Phys., Vol. 159, No. 1, 63-8 (1960).

The purpose of these experiments was to determine the variation of dark-resistance with change of temperature of thin selenium-layers in the range from room temperature to the temperature of maximum crystallization. The change of resistance of compound layers of silver on selenium and of selenium on platinum was also investigated. The instantaneous changes in resistance were recorded by means of an amplifier and oscilloscope. There is a marked difference in resistance change between pure Se, Se–Ag and Pt–Se. In the case of pure Se, the temperature at which maximum crystallization occurs can be exactly determined; in the case of Se on Pt-nuclei, crystallization takes place at a regular rate and practically without a maximum; and in the case of Ag on Se, a very marked change of resistance occurs at a temperature a good deal lower than the maximum crystallization temperature of Se. The latter observation, together with electron diffraction records of the end product, points to a chemical reaction rather than a formation of an alloy.

539.2 : 548.5

10283 GROWTH OF SINGLE CRYSTALS OF COPPER. D.S.Kemsley.

Nature (London), Vol. 186, No. 33, (April 2, 1960).

Single crystals of Cu were grown in graphite by the Bridgman method. Deformation of the crystals occurred on their removal from the moulds because of impregnation with molten Cu; the deformation affected hardness and yield stress. Impregnation was reduced with small crystals.

J.Franks

539.2 : 548.5

10284 PREPARATION OF LARGE AREA SINGLE CRYSTAL CUPROUS OXIDE. R S.Toth, R.Kilkson and D.Trivich.

J. appl. Phys., Vol. 31, No. 6, 1117-21 (June, 1960).

Large area single crystals of Cu_2O were grown by the process of high temperature annealing. Cu_2O was prepared in finely polycrystalline form by the complete oxidation of Cu plate in air at temperatures of 1020°C to 1050°C. Subsequent annealing of the polycrystalline plates at higher temperatures allowed secondary recrystallization to occur. Single crystal grains having surface areas larger than 1 in.^{2} were grown consistently on Cu_2O plates having thicknesses of 0.010 in. to 0.060 in. In some cases, entire polycrystalline plates were transformed into single crystals, and as a result, individual single crystals having surface areas of 3 in.^{2} and larger were obtained. The annealing temperature and the annealing time were found to depend markedly on the plate thickness. Thick plates required lower temperatures and longer annealing times than the thinner plates. X-ray analysis of the large grains verified that they were single crystals without excess strain, and indicated preferred orientation, with the (211) and (311) planes predominating. Resistance profile measurements at room temperature on quenched samples showed that a variation in resistance exists through the thickness of the plate.

539.2 : 548.5

10285 SECONDARY RECRYSTALLIZATION IN VACUUM ANNEALED SILICON IRON. G.Baer, D.Ganz and H.Thomas.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 235S-236S (May, 1960).

In 3% Si–Fe with high magnetocrystalline anisotropy, it is desirable to produce grain oriented material by secondary recrystallization. The size of the surface energy is an important reason for the selection of growing crystals during secondary grain growth. By studying the special crystal growth, it is essential to create well defined conditions on the surface of the sample. The surface is least disturbed if the sample is heated directly by an electric current. In such experiments, crystals were found growing either with a (110) or with a (100) orientation. The selection is influenced by the annealing temperature, by the conditions of evaporation, and by the surroundings of the sample. The growth of (110) plane grains rather than (100) grains can be understood from consideration of the surface energy.

539.2 : 548.5 : 536.48

THE PREPARATION AND PURIFICATION OF TANTALUM SINGLE CRYSTALS. See Abstr. 8955

539.2 : 548.5

10286 AN IMPROVED METHOD FOR THE GROWTH OF YTTRIUM-IRON AND YTTRIUM-GALLIUM GARNETS. J.W Nielsen.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 51S-52S (May, 1960).

Large single crystals of yttrium and rare earth iron garnets, and yttrium and rare earth gallium garnets, have been grown from molten solutions of lead oxide and lead fluoride. The crystals are grown by slowly cooling melts from about 1260°C to near 950°C. Sample compositions are: for YIG, 8 mole % Y_2O_3, 22 mole % Fe_2O_3, 30 mole % PbO and 40 mole % PbF_2; for YGaG, 5.8 mole % Y_2O_3, 14 mole % Ga_2O_3, 39 4 mole % PbO and 40.8 mole % PbF_2. This method provides crystals both large in size and of superior quality. Best results are obtained when the containing crucible is hotter near its top than at its base since nucleation is thereby reduced.

539.2 : 548.5

10287 GROWTH AND HEAT TREATMENT OF ZINC SULFIDE SINGLE CRYSTALS. A Kremheller.
J. Electrochem. Soc., Vol. 107, No. 5, 422-7 (May, 1960).

These crystals grow readily from the vapour phase if small traces of certain impurities, such as zinc oxide and copper, are present. The decrease of ambient impurity concentration leads first to very thin, flexible, ribbon-like crystals which are hexagonal, and finally to nucleation with little growth. The purity of crystals depends not only on the composition of the starting material but also on the purity of the combustion tube employed; contamination during growth leads to an impurity gradient in crystals and to impurity variations among crystals. Crystals usually exhibit disorder of the crystal structure, although pure cubic or hexagonal structure can be achieved by annealing or quenching. Heat treatment also changes the impurity content and attendant properties, such as physical colour, luminescence behaviour, electrical properties, and disorder of the crystal structure.

539.2 : 548.5

10288 [IMPURITY] CONCENTRATION DISTRIBUTION IN A ZONE-LEVELLED INGOT. V.N.Romanenko.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1679-89 (Nov., 1959). In Russian.

Mainly a mathematical analysis of impurity distributions in a bar ingot after any number of cycles of a molten zone (passage from one end to the other and back again) for (a) initially homogeneous composition. (b) the "loaded zone" technique. [See W.G.Pfann, Transactions of the American Institute of Mining (and Metallurgical) Engineers. New York, Vol. 194, 747(1952).]. The treatment is general. Distribution plots are given illustrating effects of varying the number of cycles, solid–liquid partition coefficient (k), and relative zone length (l/L). It is pointed out that for $k \leq 0.1$ 3 cycles give in practice a satisfactory approximation to perfect levelling (for $l/L \leq 0.1$), except for the last zone to freeze. Also discussed are effects of large impurity concentrations (i.e. variation in k and also in zone length during a cycle), and of imperfect mixing in the zone.
C.H.L.Goodman

539.2 : 548.5

10289 TERRACES ON ETCHPITS. J.J.Gilman.
J. appl. Phys., Vol. 31, No. 5, 936 (May, 1960).

Terraces on etchpits in LiF crystals were found to be associated with impurity precipitates. The etching rate at a precipitate differs from the rate at which the surroundings are etched.
J.Franks

539.2 : 548.5

10290 DISLOCATION ETCHINGS. G.W.Sears.
J. chem. Phys., Vol. 32, No. 5, 1317-22 (May, 1960).

The theory of preferential etching at dislocations has been presented by Cabrera. In the present paper the theory is reviewed and compared to empirical observations on the dissolution of lithium fluoride. The observed dissolution behaviour is consistent with Cabrera's theory as modified by the effect of dissolution poisons.

539.2 : 548.5

10291 ETCHING BEHAVIOR OF THE {110} AND {100} SURFACES OF InSb. H.C.Gatos and M.C.Lavine.
J. Electrochem. Soc., Vol. 107, No. 5, 433-6 (May, 1960).

Preferential and nonpreferential etching characteristics of the {110} and {100} surfaces of InSb were investigated. Since {111} facets develop in the etch figures of these surfaces, the morphology of the etch figures reflects the crystallographic polarity of InSb along the <111> directions. Dislocation etch pits were found both on the {110} and on the {100} surfaces. The role of the relative reactivities of the various crystallographic planes in the over-all etching behaviour of InSb and the effect of cold work are discussed.

539.2 : 548.5

10292 THEORY OF THE CLEAVAGE OF CRYSTALS OF MICA. M.S.Metsik.
Fiz. tverdogo Tela, Vol. 1, No. 7, 1084-91 (July, 1959). In Russian.

A theory is developed according to which the work involved in the cleavage comes from work done against dipole forces and work in the separation of a double electrical layer, giving in the final stages of interaction an electrostatic mosaic. The theory explains such fundamental phenomena as the dependence of the work on the surrounding medium, the speed of cleavage, and the thickness of the cleaved layer. Experimental data is quoted on the magnitude of this work for cleavage under water, ethyl alcohol, benzine, moist and dry air, and from this is calculated the concentration of charges in the double layer, the initial distance between the charges, and the charge density of the electrostatic mosaic. W.Bardsley

539.2 : 548.7

10293 INTERFEROMETRIC STUDIES ON SYNTHETIC DIAMONDS. S.Tolansky and I.Sunagawa.
Nature (London), Vol. 185, 203-4 (Jan. 23, 1960).

A number of two-beam interferometric studies on the surfaces of General Electric synthetic diamonds are reported. Distinctions between the synthetic and natural diamonds are noted. The fringes shown by synthetic cubic planes show these to be flat and uniform, in contradistinction to natural cube faces. Many synthetic octahedra are shown to have a skeletal or hopper formation, revealing a fairly plane raised parapet surrounding a hollow. In contradistinction to natural diamonds where slip is uncommon, on synthetics slip is very frequent and the fringes reveal that the frequent slip has the character of a screw dislocation. Slip-steps are high, ranging from 500 to 15 000 A. Well defined linear trigons appear on numerous faces, and as in natural diamonds these at times "sit" on a linear dislocation. S.Tolansky

539.2 : 548.7

10294 DETERMINATION OF ORIENTATION OF BISMUTH SINGLE CRYSTALS USING BACK-REFLEXION TECHNIQUE. H.D.Mallon and C.G.Wilson.
Brit. J. appl. Phys., Vol. 11, No. 6, 229-41 (June, 1960).

The ambiguity in interpretation of orientation from back-reflection photographs of bismuth single crystals is resolved by taking photographs about the trigonal axis or the normal to the (111) plane. The trigonal axis which is also the optic axis is uniquely determined by using polarized light.

539.2 : 548.7

10295 ENHANCEMENT OF THE HIGH-SPACING MERIDIONAL REFLEXIONS IN THE X-RAY PHOTOGRAPH OF KERATIN IMPREGNATED WITH HEAVY-METAL SALTS. W.S.Simpson and H.J.Woods.
Nature (London), Vol. 185, 157 (Jan. 16, 1960).

Several different kinds of keratin fibres have been impregnated with mercury acetate or silver nitrate, after treating with thioglycollic acid to reduce the disulphide groups. Considerable enhancement of the intensity of some of the orders of X-ray diffraction were observed with mercury but the most striking effects were produced when Lincoln wool fibres were impregnated with silver. In the latter, all orders from third to tenth were exceptionally enhanced. It is suggested that the silver is spread out at intervals of approximately 25 A along the fibre axis. J.Ball

539.2 : 548.7

10296 MERIDIONAL REFLEXIONS IN THE X-RAY DIFFRACTION PHOTOGRAPHS OF α-KERATIN. W.J.Onions, H.J.Woods and P.B.Woods.

Nature (London), Vol. 185, 157-8 (Jan. 16, 1960).

X-ray photographs of six forms of α-keratin were taken with Cu Kα radiation in a vacuum camera at specimen-to-film distances of 20 and 24 cm. Photometer tracings of the photographs are reproduced for three groups of specimens, (a) porcupine quill tip; (b) Lincoln wool and kid mohair; (c) human hair, horse hair and pig bristle. The differences observed between the diffraction patterns may indicate differences in the sequence of amino-acid residues in the protein chains. J.Iball

539.2 : 548.7

10297 EXTENSION OF THE RECIPROCAL LATTICE RECORD BY THE COMPOSITE PRECESSION PHOTOGRAPH. Chang Yuan-Lung.

Science Record (China), New Series, Vol. 4, No. 1, 65-9 (Jan., 1960).

It is shown how part of the zero level and part of the second level may be recorded on one photograph. A.R.Stokes

539.2 : 548.7

10298 THE POLARIZATION CORRECTION FOR UPPER LEVEL GEOMETRY USING CRYSTAL MONOCHROMATIZED RADIATION. H.A.Levy and R.D.Ellison.

Acta cryst., Vol. 13, Pt 3, 270-1 (March, 1960).

The polarization correction depends on the orientation of the monochromator crystal relative to that of the reflecting planes of the specimen. A formula of Azaroff (Abstr. 4099 of 1956), which takes this into account, is put into a suitable form for crystallographic calculations. A.R.Stokes

539.2 : 548.7

10299 THE CORRELATION OF INTERSECTING LAYERS OF X-RAY INTENSITY DATA. J.S.Rollett and R.A.Sparks.

Acta cryst., Vol. 13, Pt 3, 273-4 (March, 1960).

The methods of Kraut [Acta cryst., Vol. 11, Pt 12, 895 (Dec., 1958)], and Dickerson (Abstr. 3200 of 1960) are criticized as unsound, and another method is described. A.R.Stokes

539.2 : 548.7

10300 THE INFLUENCE OF BINDING ELECTRONS ON X-RAY INTENSITIES. R.Brill.

Acta cryst., Vol. 13, Pt 3, 275-6 (March, 1960).

Good agreement is found between recent measured intensities of reflection from diamond and intensities calculated from a formula based on Ewald and Hönl's theoretical electron distribution (Abstr. 1738, 4259 of 1936). A.R.Stokes

539.2 : 548.7

10301 THE INFLUENCE OF A MAGNETIC FIELD ON THE INTENSITY OF X-RAY REFLECTIONS. L.A.Smirnov.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1853 (Dec., 1959). In Russian.

The experiments of an earlier worker were repeated with an improved recording system and it was concluded that a magnetic field had no influence on the intensity of reflection. The earlier results may have been due to mechanical distortion of the reflecting crystal. A.E.I. Research Laboratory

539.2 : 548.7

10302 A COMPARISON OF ANISOTROPIC DIFFERENTIAL FOURIER AND LEAST-SQUARES REFINEMENT. G.A.Jeffrey and R.Shiono.

Acta cryst., Vol. 12, Pt 10, 819 (Oct., 1959).

It is concluded from data obtained by refining a crystal structure by both methods that there is no significant difference between the results of the two procedures. A.R.Stokes

539.2 : 548.7

10303 EXTENSION OF THE M FUNCTION TABLES FOR A HINDERED ROTATOR OF LIPSCOMB AND KING. H.Chessin and R.W.Whitmore.

Acta cryst., Vol. 13, Pt 3, 274 (March, 1960).

See Abstr. 4485 of 1950. Details are given of tables of X-ray scattering amplitudes which are obtainable on application. A subroutine programme for use on the IBM 650 computer is also available. A.R.Stokes

539.2 : 548.7

10304 DETERMINATION OF DEFORMATION STACKING FAULTS IN CUBIC FACE-CENTRED METALS BY X-RAYS. M.Wilkens.

Z. Phys., Vol. 158, No. 4, 483-500 (1960). In German.

Formulae for the distribution of diffracted intensity in reciprocal space are obtained in terms of statistics of distances between faults in the stacking of close-packed layers. A.R.Stokes

539.2 : 548.7

10305 A MICROGRAPHIC ESTIMATION OF CRYSTAL DISTORTION. T.Tomita.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 2, 131-6 (1959).

The X-ray diffraction micrograph of the crystal surface is studied in connection with the divergency and spectrum of the incident beam and the order of crystal distortion. The local distortion of the crystal surface can be estimated over a wide range of the surface from the monochromatic ranges recognized in a number of diffraction spots.

539.2 : 548.7 : 539.3

10306 PROGRESSIVE LATTICE DISTORTION IN STRESSED CRYSTAL LAMELLAE. F.W.Cuckow.

Proc. Roy. Soc. A, Vol. 250, 427-38 (April 7, 1959).

The literature contains many references to the appearance of fringe patterns on crystals, under examination in the electron microscope, which are attributed to bending of the crystal. An unusually detailed and extensive but still incomplete pattern is presented in an electron micrograph of a sodium chloride crystal sheet. The corresponding electron diffraction pattern was of the "two-dimensional" type. Diffraction and fringe patterns were present throughout extensive rotation of the specimen. The fringe pattern is repetitive and cannot be explained by reasonable degrees of bending of the sheet. It is shown to be consistent with the loss of electrons by Bragg reflection from a lamellar single crystal in a special state of shear strain. Ideally, the strain progresses uniformly in all radial directions but is considered to have been induced experimentally by the contraction of a membrane attached to one side acting in opposition to the natural rigidity of the crystal. For the ideal state of strain it is shown that the fringe pattern is an enlargement by a two-dimensional vernier coincidence process of the intersections of origin reflecting planes with the basal plane, the magnification being simply related to the shear strain. The pattern is identical geometrically with Neumann's linear crystallographic projection. See also following abstract.

539.2 : 548.7 : 539.3

10307 RECONCILIATION OF TWO-DIMENSIONAL ("CROSS-GRATING") AND THREE-DIMENSIONAL PHENOMENA IN ELECTRON DIFFRACTION AND RESOLUTION OF OTHER ANOMALIES ON THE BASIS OF BRAGG REFLEXIONS FROM SINGLE CRYSTAL LAMELLAE SUFFERING RADIALLY PROGRESSIVE SHEAR STRAIN. F.W.Cockow.

Proc. Roy. Soc. A, Vol. 250, 439-59 (April 7, 1959).

An intricate repetitive fringe pattern, due to the loss of electrons by diffraction from a crystal lamella, was explained earier in terms of a crystal model in a state of progressive shear strain in which the primitive translations of successive net-planes changed progressively through the thickness of the layer. The electron diffraction pattern to be expected from this three-dimensional model is now shown theoretically to be identical geometrically with the diffraction pattern from the two-dimensional array of atoms in a single constituent net-plane comprising a cross-grating, so that the model offers also a simple explanation of two-dimensional ("cross-grating") diffraction effects in terms of conventional theory for diffraction from three-dimensional crystals. Normal size diffraction rings would not arise from an assembly of the model crystals, but closely similar rings would appear following the law $n\lambda = d \sin 2\theta$, as distinct from the Bragg law $n\lambda = 2d \sin \theta$, when, for example, the beam was normal to the shear plane and parallel to the reflecting planes prior to the incidence of strain. While such near-normal rings could be arranged in families comprising "bands". These bands would have a "head" on an paarently normal ring and a "tail" on an "extra" ring. Comparison of the model with other published data in electron diffraction suggests that is is compatible with a recently published observation of excessive d_{111}/d_{200} and d_{111}/d_{220} spacing ratios in biological work, with early work showing "extra" rings and "bands" from electro-deposited metal films, with "extra" rings from metal foils and with small beam deviations down to zero corresponding to infinite spacings. The model, based directly on effects observed experimentally, and now shown to be supported by previously published work, needs to be examined theoretically from the point of view of stability and in connection with both Frank and van der Merwe's

theory (1949) of orientation calling for pseudomorphic monolayers and Finch and Quarrell's work (1933-5) which led to the concept of basal plane pseudomorphism.

539.2 : 548.7

10308 THE CONTRAST, BREADTHS AND RELATIVE INTENSITIES OF ELECTRON DIFFRACTION RINGS.

J.S.Halliday.

Proc. Roy. Soc. A, Vol. 254, 30-47 (Jan. 19, 1960).

A theoretical expression for the contrast of transmission electron diffraction patterns is developed, assuming kinematical conditions. The effects of the accelerating voltage, the specimen thickness, crystallite size and amorphous content are discussed. Experimental measurements of the contrast of diffraction patterns obtained with iron specimens are compared with the theoretical predictions. Theory and experiment show that the highest contrast is obtained in single scattering conditions and that the contrast is then independent of specimen thickness and accelerating voltage. In plural scattering conditions the contrast rapidly diminishes with increasing thickness and decreasing voltage. However, the reduced contrast remains constant if the ratio of the specimen thickness over the electron mean free path is kept constant. The experimental variation of the contrast with this ratio agrees with that predicted, and has the same form for all rings. Results obtained with other materials by previous workers are shown to agree with the present theory and results. The effect of plural electron scattering on ring breadths and intensities has been measured. It is shown that broadening is caused by very small angle scattering of diffracted electrons, and that true estimates of crystallite size can be made in single scattering conditions. The relative ring intensities are, however, unaffected even when the proportion of scattered electrons within the ring profiles is large. The effect of accelerating voltage on the extent of dynamical diffraction conditions is compared with that predicted by Blackman (1939). The experiments indicate that dynamical conditions arise with crystallites six times smaller than those predicted by Blackman.

539.2 : 548.7 : 539.18

10309 MEASUREMENT OF ATOMIC DIFFERENTIAL SCATTERING CROSS-SECTIONS. J.S.Halliday.

Brit. J. appl. Phys., Vol. 11, No. 6, 259-63 (June, 1960).

The derivation of the atomic differential-scattering cross-section $(d\sigma_T/d\omega)_\theta$ from the intensity distribution in the background of electron diffraction patterns is discussed, bearing in mind the possible effects of plural scattering. It is shown that the variation of $(d\sigma_T/d\omega)_\theta$ with specimen thickness reported by Haine and Agar (Abstr. 5864 of 1960) is not real but appeared because the decrease in the unscattered intensity was over-estimated. After correction, their values for $(d\sigma_T/d\omega)_\theta$ are in reasonable agreement with Lenz's (Abstr. 7490 of 1954) theoretical values for angles between 10^{-3} and 2×10^{-3} radians, but the experimental rate of decrease of $(d\sigma_T/d\omega)_\theta$ with increasing angle is smaller than expected. The effect of plural scattering on the intensity distributions from thicker specimens is not as great as that predicted by Lenz.

539.2 : 548.7

10310 A NEW POLYMORPH OF BORON.

C.P.Talley, S.Laplaca and B.Post.

Acta cryst., Vol. 13, Pt 3, 271-2 (March, 1960).

Unit cell is tetragonal, pseudo-cubic, with a = 10.12 A, c = 14.14 A, containing probably 192 atoms. Preparation and analysis are described. A.R.Stokes

539.2 : 548.7

10311 THE LATTICE SPACING OF THORIUM, WITH REFERENCE TO CONTAMINATION.

D.S.Evans and G.V.Raynor.

J. nuclear Mater., Vol. 1, No. 3, 281-8 (Oct., 1959).

In view of the wide range of values reported in metallurgical literature for the lattice spacing of thorium, the effects of contamination, and methods for minimizing such contamination, have been investigated. Serious contamination, chiefly by nitrogen, has been found to occur if the filings are prepared in air. Other stages at which contamination occurs are on exposure to air of filings prepared out of contact with air, on annealing in vacuo at pressures as low as 5×10^{-6} mm Hg, and on initial heating up to the annealing temperature by gas evolved from the walls of the boats in which the filings are contained. Unless stringent precautions are taken, results varying from 5.0740 kX to 5.089 kX may be obtained. The necessary precautions are discussed, and it is shown that by preparing filings out of contact with air, and avoiding all contact with air prior to heat-treatment, stress-relief anneals may be successfully carried out in closed or sealed boats of tantalum foil without introducing impurity in sufficient quantity to affect the lattice spacings by amounts exceeding normal experimental error. The lattice spacing of iodide thorium was determined as 5.0741 ± 0.0002 kX; values in the range 5.078 to 5.082 kX correspond to material highly contaminated or saturated with introduced nitrogen.

539.2 : 548.7

10312 POLARIZED OCTAHEDRA IN BARIUM TETRATITANATE. D.H.Templeton and C.H.Dauben.

J. chem. Phys., Vol. 32, No. 5, 1515-21 (May, 1960).

Single-crystal X-ray diffraction studies show that $BaTi_4O_9$ is orthorhombic, space group Pmmn, with a = 14.53 ± 0.02, b = 3.79 ± 0.01, and c = 6.29 ± 0.01 A, with two formula units per unit cell and calculated density 4.54 g cm^{-3}. Each barium atom has four oxygen neighbours at 2.81 A, two at 2.96, and four at 3.09, at the corners of a pentagonal prism. Titanium atoms are in distorted octahedra of oxygen atoms. The Ti–O distances range from 1.77 to 2.32 A, with standard deviations of 0.03 A or less. Titanium atoms occur at points 0.30 and 0.21 A from the centres of gravity of the oxygen atoms of the two kinds of octahedra. This polarization of the two octahedra is similar to or greater in magnitude than that observed in the ferroelectric phases of $BaTiO_3$ and $PbTiO_3$.

539.2 : 548.7

10313 A TWINNING INTERPRETATION OF "SUPERLATTICE" REFLEXIONS IN X-RAY PHOTOGRAPHS OF SYNTHETIC KLOCKMANNITE, CuSe. C.A.Taylor and F.A.Underwood.

Acta Cryst., Vol. 13, Pt 4, 361-2 (April, 1960).

Optical transform methods are used to elucidate the crystal structure of klockmannite. Results obtained to date indicate that certain observed X-ray reflections are due to twinning and therefore the true a dimension of the crystal is 14.26 A rather than the accepted 51.40 A. The c dimension is still taken as 17.25 A. J.Adam

539.2 : 548.7 : 537.311

CRYSTAL STRUCTURE OF In–Sb–Te ALLOYS.

See Abstr. 9978

539.2 : 548.7

10314 NOTE FOR STRUCTURE ANALYSIS OF SILICON CARBIDE OF 174 LAYERS. T.Tomita.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 2, 115-29 (1959).

For the structure analysis of the modifications of silicon carbide crystal having a long c-period, a number of possible model structures should be assumed in order to find the most reliable structure. The number of possible models is somewhat reduced by considering some criteria concluded from characteristic features of intensity distribution as shown in the author's previous study of silicon carbide of 174 layers. The criteria referred to are cussed and somewhat generalized in this paper.

539.2 : 548.7

10315 ZIRCONIUM CARBIDE.

C.P.Kempter and R.J.Fries.

Analyt. Chem., Vol. 32, No. 4, 570 (April, 1960).

X-ray powder diffraction data for high purity ZrC is presented and used to calculate the lattice constant. The value given of 4.69764 ± 0.00005 A is shown to be insensitive to the presence of as much as 2% hafnium as an impurity. R.Bullough

539.2 : 548.7

10316 X-RAY INVESTIGATION OF THE SYSTEM ZnS–FeS.

J.T.S.van Aswegen and H.Verleger.

Naturwissenschaften, Vol. 47, No. 6, 131 (1960). In German.

The lattice spacing was measured for pure ZnS and for samples containing Fe up to 21.54%. The spacing varied considerably up to about 15% Fe but thereafter the change was small. J.M.Hough

539.2 : 548.7

10317 THE CRYSTAL STRUCTURE OF Zr_3Al_2.

C.G.Wilson and F.J.Spooner.

Acta cryst., Vol. 13, Pt 4, 358-9 (April, 1960).

Tetragonal, a = 7.630 ± 0.001 A; c = 6.998 ± 0.001 A. Space

group D_{4h}^{14} - $P4_2/mnm$. Atomic positions given approximately as:

8 Al (j) xxz with x = $\frac{1}{6}$, z = 0.21
4 Zr (f) xx0 " x = 0.34
4 Zr (g) xx0 " x = 0.20
4 Zr (d) $0\frac{1}{2}\frac{1}{4}$

The structure is discussed in terms of principles of sphere packing in complex alloy structures due to Frank and Kasper [Acta cryst., Vol. 11, Pt 3, 184-90 (March, 1958) and Abstr. 10385 of 1959)].

J.Adam

539.2 : 548.7

10318 THE STRUCTURE OF METHYL 1 : 2-BENZANTHRAQUINONES. I. CRYSTAL DATA.

R.P.Ferrier and J.Iball.
Acta. cryst., Vol. 13, Pt 2, 162-3 (Feb., 1960).

The unit cells and space groups of 1 : 2-benzanthraquinone and of 8 of the possible 10 mono-methyl substituted derivatives are given. The 2'- derivative had two crystal forms, both monoclinic. J.Iball

539.2 : 548.7

10319 CRYSTAL STRUCTURE OF MELLITIC ACID.

A.Bezjak and D.Grdenić.
Nature (London), Vol. 185, 756-7 (March 12, 1960).

VARIOUS SOLID STRUCTURES

539.213

10320 LOW-ANGLE X-RAY SCATTERING BY SODIUM BOROSILICATE GLASSES.

E.A.Porai-Koshits and N.S.Andreyev.
J. Soc. Glass Technol., Vol. 43, 235-261T (Aug., 1959).

The basic hypotheses of the structure of monocomponent glass are discussed and the problem of the presence in complex glasses of "local chemical order" is considered. This problem was investigated by low-angle X-ray scattering; first porous Vycor glasses were studied and then the orginal sodium borosilicate glasses. For the first time low-angle X-ray scattering for a series of specimens of such glass was obtained, proving their chemical inhomogeneity. The dimensions of these inhomogeneities were measured, and were found to depend on the heat treatment of glass and to approach the pore size of the corresponding leached glass. The change in the intensity of light scattering by the heat-treated sodium borosilicate glasses is explained by the change in the inhomogeneity dimensions. It is shown that the growth of these regions with the increase of temperature is achieved both at the expense of the surrounding silica (i.e. with change of composition) and by means of recondensation — that is by formation of large inhomogeneities at the expense of the small ones (without change in composition). By comparing the intensity of low-angle scattering by the original and leached glasses the difference in electron density of the silica-skeleton and the second glass component was determined and was found to be about 0.03 el/A^3. The intensity of low-angle scattering for glasses with small dimensions of inhomogeneity was estimated and this calculation explains why all attempts to find low-angle X-ray scattering by glasses of other compositions have failed.

539.213

10321 STRUCTURAL CHANGES DURING THE MELTING OF CRYSTALS AND GLASSES.

W.A.Weyl and E.C.Marboe.
J. Soc. Glass Technol., Vol. 43, 417T-437T (Dec., 1959).

The kinetics of melting of a substance can follow several patterns. The melting of quartz and of albite is an example of one extreme. These crystals melt as nearly perfect crystals by gradually changing into viscous liquids. Their melting points can be determined only by static methods because the crystals can be overheated easily and the heating above the melting temperature does not produce drastic changes in their rheology. Sodium chloride is an example of the other extreme. Above the Tammann temperature defects migrate into the crystals which it is assumed will produce fissures and cause the binding forces to disproportionate into stronger and weaker forces. The stronger forces (smaller internuclear distances) lead to ionic clusters which may be free to oscillate and to rotate. These clusters are separated by fluctuating fissures which permit the salt to become very fluid right above the melting point. The tendency of a substance to form a glass is related to the concentration of defects, in particular of vacant anion sites, in the crystal close to the melting point. SiO_2 in contrast to TiO_2 or SnO_2 is not likely to develop anion vacancies even at high temperature. The structures of molten substances determine their nucleation behaviour, their viscosities and their abilities to form fibres and films.

539.213

10322 ATOMIC CHAINS AND THE FINE STRUCTURE OF GLASS. V.V.Tarasov.

Zh. tekh. Fiz., Vol. 27, No. 7, 1521-33 (July, 1957). In Russian.

A review of the subject under the following headings: glasses as heterodynamic structures; whether glasses are inorganic high polymers; whether distant order exists in glasses; structure of melted glass; fine structure of glass—the role of chain formation; study of the fine structure of anomalous phosphate glasses with the aid of ultrasonics. A synthesis of the various theories is attempted on the basis of the author' s quantum theory of the heat capacity of heterodynamic structures. R.F.S.Hearmon

539.214

10323 TECHNIQUE FOR REPLICATING FIBRE SURFACES BY ROLLING. J.Mølgaard.

J. sci. Instrum., Vol. 37, No. 6, 210-11 (June, 1960).

Short lengths of fibre with cylindrical cross-section are placed on a plastic film and rolled, thereby replicating the entire fibre surface. The replicas are examined by phase contrast. Nylon fibre surfaces are illustrated.

539.214

10324 THE ANISOTROPIC THERMAL EXPANSION OF POLYTETRAFLUOROETHYLENE ROLLED IN ONE DIRECTION. A.V.Sidorovich and E.V.Kuvshinskii.

Zh. tekh. Fiz., Vol. 29, No. 10, 1271-2 (Oct., 1959). In Russian.
English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1165-6 (April, 1960).

Results of investigations on the linear thermal expansion of rolled polytetrafluoroethylene film are given. Specimens parallel to the direction of rolling slow anomalies in the region 20-25°C. A hysteresis effect is also exhibited. E.G.Knowles

539.214 : 539.3

STUDY OF VISCOUS FLOW OF RUBBERS. See Abstr. 10266

539.215

10325 COVERING OF PLANE SURFACE WITH INEQUIGRANUAL POWDERS. J.Weiszburg and I.Hangos.

Acta phys. Hungar., Vol. 10, No. 4, 359-70 (1959).

The description of the fractional covering of a plane surface by means of powder grains has been extended to include inequigranular powders. Mixtures of two or three partial fractions each having a small grain size range, and also wide grain size distributions were used in the experiments. The coverage obtained as a function of the areal density of the powder is adequately described by the authors for sedimented halophosphate powders, earlier work on homogeneous grain size distribution being explained as a special case of this more advanced study. I.Cooke

539.215

10326 LABORATORY MAGNETIC ELUTRIATOR FOR PURIFICATION AND ISOLATION OF FERRIMAGNETIC MINERAL SANDS. W.R.B.Martin.

J. sci. Instrum., Vol. 37, No. 6, 212-15 (June, 1960).

An apparatus is described which allows almost total removal of not-completely homogeneous magnetic grains from ferrimagnetic mineral sand, and will further separate strongly remanent from weakly remanent grains. Magnetic-field strengths and water-flow velocities required for material of size 60 to 200 B.S. mesh, and a scale drawing of the separation tube are given.

539.219

10327 SOLID SOLUTIONS IN QUATERNARY SYSTEMS BASED ON InAs AND InSb. N.A.Goryunova and V.D.Prochukhan.

Fiz. tverdogo Tela, Vol. 2, No. 1, 176-8 (Jan., 1960). In Russian.

Solid solutions were studied in the systems (1) InAs–$CdSnAs_2$;

(2) InSb–$CdSnSb_2$. In (1), chalcopyrite structure was maintained up to $CdSnAs_2$.2InAs; alloys richer in InAs had zinc blende structure. Microhardness was greatest (H_{max} = 414 kg/mm^2) for 2InAs.3$CdSnAs_2$. From heating curves the temperature at which melting commenced (T_m) increased with InAs content from ~615°C for $CdSnAs_2$ to ~852°C for 18InAs.$CdSnAs_2$. In (2) single phase alloys, all with zinc blende structure, were obtained only up to ~2InSb.$CdSnSb_2$ ($CdSnSb_2$ itself is unstable, see Abstr. 7102 of 1957 and 13776 of 1959). H_{max}, 273 kg/mm^2, was for 8InSb.$CdSnSb_2$. T_m for 2InSb.$CdSnSb_2$ was 424°C. Ordering in such quaternary alloys is briefly discussed. C.H.L.Goodman

539.219

10328 PREPARATION OF HOMOGENEOUS SOLID SOLUTIONS IN THE AlSb–InSb. B.V.Baranov and N.A.Goryunova. Fiz. tverdogo Tela, Vol. 2, No. 2, 284-7 (Feb., 1960). In Russian.

The following method was used for the preparation of homogeneous AlSb–InSb solid solutions: the component metals were melted in argon, in graphite crucibles, placed in sealed silica ampoules, vibration being used to ensure thorough mixing; after holding at 1100°C, the molten alloy was quenched in brine and the solidified specimens were homogenized by annealing for 120 hr at about 600°C, i.e. at temperatures higher than the melting point of the lower-melting-point constituent. The results of X-ray analysis, metallographic examination and hardness measurements, as well as their higher (in comparison with AlSb) corrosion resistance, confirmed the homogeneous nature of the alloys obtained in this manner. The effectiveness of the method employed was attributed to the increased (due to the finely crystalline structure of the quenched alloys) area of contact between the two phases, and to the beneficial effect of the liquid phase, present in the alloys during the annealing treatment, on the diffusion process. M.H.Sloboda

539.219

10329 HOT WORKING OF ALNICO 5 ALLOYS. C.L.Kolbe and D.L.Martin. J. appl. Phys., Suppl. to Vol. 31, No. 5, 84S-85S (May, 1960).

Alnico permanent magnet alloys have been successfully shaped into rod, wire and strip by hot working at elevated temperature. It has been found that by carefull processing, certain Alnico alloys can be fabricated by extrusion, swaging, and rolling. The wrought Alnico after heat treatment was found to have comparable permanent magnet properties and improved mechanical properties compared to cast specimens of the same alloy.

539.219

10330 A NECESSARY FACTOR FOR HEAT TREATMENT OF THE PERMALLOYS IN A MAGNETIC FIELD. E.A.Nesbitt, R.D.Heidenreich and A.J.Williams. J. appl. Phys., Suppl. to Vol. 31, No. 5, 228S-229S (May, 1960).

Perminvar (Ni-Fe-Co alloy) has an inhomogeneous structure due to an impurity fault. Evidence has been obtained that small amounts of oxygen as an impurity in Perminvar caused both the faulting and the heat treatment in a magnetic field. Magnetic torque curves on a single crystal of 63% Ni-35% Fe-2% Mo for two different heat treatments illustrate the effect of oxygen on the response to magnetic annealing of Permalloys. When the crystal was purified in hydrogen and then heat treated in a magnetic field, it did not respond. However, after slightly oxidizing heat treatment (pot annealing at 1000°C for 16 hrs), it did respond to the field heat treatment by developing a uniaxial anisotropy of approximately 2000 ergs per cm^3. The intimate connection between the presence of impurity faults and the ability to respond to heat treatment in a magnetic field is shown by observations on single crystals of 68% Ni-31.9% Fe-0.1% Mg, which were grown for this purpose. The (100) surfaces of these crystals showed heavily and lightly faulted regions. The work on the Perminvars has shown that the heavily faulted areas contain more oxygen than the lightly faulted areas. The magnetic torque measurements on the 68% Ni alloy confirm this idea. The heavily faulted crystal had a uniaxial anisotropy of approximately 3000 ergs per cm^3 while the lightly faulted crystal had a value of only 1000 ergs per cm^3.

539.23

10331 TENSILE PROPERTIES OF THIN, EVAPORATED GOLD FILMS. C.A.Neugebauer. J. appl. Phys., Vol. 31, No. 6, 1096-101 (June, 1960).

Evaporated gold films in the 500-15 000 A thickness range were prepared on rocksalt substrates. Depending on the temperature of the substrate during deposition, the films were completely, partially, or randomly oriented with respect to the (100) plane of the rocksalt, as determined by X-ray diffraction. The stress–strain curve of the free films was investigated, and was found to be quite steep up to very high stresses, but plastic deformation and creep were observed even at relatively low stresses. The ultimate tensile strength of the films is from 2 to 4 times that of the annealed bulk material and is not a function of film thickness. The Young's moduli are found to be normal. Comparing the stress–strain behaviour of evaporated films with that of whiskers suggests that the former owe their high strength to a high concentration of defects which were uniformly quenched in during the evaporation process, and which greatly impede dislocation motion and multiplication, and not to an abnormally high stress required to nucleate dislocations which is commonly observed in whiskers.

539.219

10332 AN INVESTIGATION OF STRUCTURAL CHANGES CAUSED BY NEUTRON IRRADIATION OF A URANIUM MOLYBDENUM ALLOY. S.T.Konobeevskii, N.F.Pravdyuk, K.P.Dubrovin, B.M.Levitskii, L.D.Panteleev and V.M.Golianov. J. nuclear Energy, Vol. 9, No. 1-4, 75-89 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 34 (1958).

Specimens of an alloy containing 9 wt % Mo were irradiated. The electrical resistance was measured and the structure examined by X-ray diffraction and metallographic techniques. The specimens were prepared by suitable heat treatment to have eutectoid $\alpha + \gamma'$ structures with various degrees of dispersion. It was established that the rate of homogenization of these two-phase structures during irradiation was inversely proportional to the square of the thickness of the laminae in the eutectoid. In the homogeneous γ-phase changes in structure and properties under irradiation are essentially complete in 2-4 hr. The ordered γ'-phase was found to be disordered after a few hours of exposure to neutrons. All these phenomena can be adequately explained on the basis of the theory already published [Atomnaya Energiya, Vol 2, 63 (1956)]. However the size of the thermal spike and the energy dissipated were found to be smaller than determined previously and were 2.5×10^{-17} cm^3 and 2 MeV respectively.

539.219

10333 STABILIZATION OF THE γ PHASE IN THE TERNARY ALLOYS WITH A URANIUM-MOLYBDENUM BASE. G.Cabane and G.Donzé. J. nuclear Mater., Vol. 1, No. 4, 364-73 (Dec., 1959). In French.

The stability of the γ-phase in uranium-molybdenum alloys can be increased by a ternary addition. The effect of the following elements was studied: chromium, niobium, rhenium, ruthenium and zirconium. The molybdenum content was progressively reduced so as to maintain a constant atomic concentration of solute; the alloys fall into three groups containing respectively 14, 16 and 18 at.% of solute. Only zirconium reduces the stability of the γ-phase, and it is also the only one among the solutes listed which has a larger atomic radius than has uranium. It appears that the metastability of the γ-phase in the $\alpha + \gamma'$ field arises primarily from the contraction of the cubic lattice through the substitution of small atoms. In the concentration range investigated it appears that there is for each favourable ternary solute an optimum concentration, beyond which the stability does not increase further or else tends to return towards the value characteristic of the binary U-Mo alloy. The stabilizing capacity of the addition elements is relatively the greater, the smaller the total concentration of addition elements. Finally the comparison of the different alloys from the point of view of reactivity demonstrates the great interest of ternary solutes: for a given loss of reactivity the replacement of some molybdenum by ruthenium allows the period of incubation to be increased by a factor of 5.

539.219

10334 OPTICAL AND ELECTRON-DIFFRACTION STUDY OF GOLD–TIN ALLOYS PREPARED BY SIMULTANEOUS VACUUM DEPOSITION. E.Toma, I.Teodoresku and G.Kholloah. Rev. de Physique (Bucarest), Vol. 4, No. 3, 317-26 (1959). In Russian.

With the aid of a technique which involved simultaneous vacuum deposition of the two components, contained in separate, conveniently placed and screened crucibles, thin films were prepared, whose composition changed gradually from pure Au at one end to pure Sn at the other. A well-defined relationship between the composition and reflectivity of various parts of the films was established, although the exact position of only one intermetallic compound (AuSn)

could be determined from the reflectivity spectrum. However, accurate data on the number and crystal structure of the phases, present in the system, were easily obtained by the electron-diffraction technique. It was concluded that the method described is eminently suitable for rapid determination of the constitution of alloys of binary systems.
M.H.Sloboda

539.23

10335 FILM STRIPPING TECHNIQUE FOR MAKING THIN SILICA WINDOWS. E.Tannenbaum.
J. appl. Phys., Vol. 31, No. 5, 940 (May, 1960).

The experimental techniques required to construct transparent silica windows from 1000 to 100 000 A in thickness and up to 1 cm^2 in area are described in detail. The method makes use of the high temperature reaction between silicon and chlorine with the formation of silicon tetrachloride; SiO_2 is not attacked by chlorine so the silicon may be selectively etched away. One of the uses of the technique has been a study of imperfections in oxidized surfaces.
R.Bullough

539.23

10336 ELECTRON PROBE MEASUREMENTS OF EVAPORATED METAL FILMS.
W.E.Sweeney, Jr, R.E.Seebold and L.S.Birks.
J. appl. Phys., Vol. 31, No. 6, 1061-4 (June, 1960).

Calibration curves of X-ray intensity versus specimen thickness have been prepared for the electron probe microanalyzer by using evaporated films of Cr, Mn, Zn, and Au in the 0-5000 A range. For each element, the X-ray intensity increased almost linearly with thickness; for a given thickness, the X-ray intensity increased (but not linearly) with atomic number. Using previously published data on electron excitation efficiency to calculate expected X-ray intensities, the measured values from Cr, Mn, and Au were about 0.75 to 0.85 times the calculated value whereas Zn was about 1.25 times the calculated value. The variations are throught to result from some undetermined parameter such as density or internal strain.

539.23

10337 PHOTO-INDUCED GROWTH OF ANODIC TANTALUM PENTOXIDE FILMS.
A.R.Bray, P.W.M.Jacobs and L.Young.
J. nuclear Mater., Vol. 1, No. 4, 356-63 (Dec., 1959).

Ultraviolet irradiation produces first an electronic and later an ionic photocurrent. It has been confirmed that the photoeffects are due to light absorbed by the oxide (not by the metal). The absorption coefficient of the oxide has been determined by transmission and reflectivity measurements and is about 2×10^5 cm^{-1} at a wavelength of 2500 A. The electronic photocurrent measured at a given field strength in the oxide increases with thickness in parallel with the amount of light absorbed, except that fatigue effects increase with thickness, and, therefore, tend to cause the photocurrent to become constant before the thickness is reached which absorbs all the light which is not reflected or lost to the metal. The electronic photocurrent as a function of field strength shows a saturation effect with thin films, but this disappears with increasing thickness. The onset of photo-induced growth occurs after an induction period in which the properties of the film are slowly modified. Once the induced ionic current has appeared, it decays only gradually after the removal of the light. The photo-induced growth is demonstrated by a colour change and a weight increase, which are mutually consistent.

539.23

10338 EFFECTS OF FAST-NEUTRON IRRADIATION ON NICKEL THIN FILMS. I.Teodorescu and A.Glodeanu.
Phys. Rev. Letters, Vol. 4, No. 5, 231-2 (March 1, 1960).

Thin films produced by evaporation in vacuum transformed from the face centred cubic to closed packed hexagonal form under fast neutron irradiation at 59°C in vacuum to a dose of 3.38×10^{17} nvt. Drastic changes in magnetic properties were also observed. There was no phase change in samples irradiated in oxygen to similar doses.
J.Adam

539.23 : 535.8

ANNEALING SILICON MONOXIDE FILMS ON ALUMINIUM MIRRORS. See Abstr. 8783.

539.23 : 669

INTERMETALLIC REACTIONS AND AGEING EFFECTS IN THIN FILMS. See Abstr. 10463

X-ray and Electron Microscope Examination

539.27

10339 SINGLE-ETCH EXTRACTION REPLICA METHOD ADAPTED FOR CARBON FILMS.
G.R.Booker and J.Norbury.
Brit. J. appl. Phys., Vol. 10, No. 12, 543 (Dec., 1959).

High quality replicas of metal specimens result from evaporating a carbon film on the etched and rinsed surface. After backing with collodion, followed by dry stripping, the collodion is dissolved. For specimens containing areas of included materials, the collodion is applied first. After dry stripping, carbon is evaporated on the under side and the collodion removed.
R.Reed

539.27

10340 TILTING AND ROTATING SPECIMEN STAGE FOR ELECTRON MICROSCOPY AND ELECTRON DIFFRACTION. R.E.Burge and H.R.Munden.
J. sci. Instrum., Vol. 37, No. 6, 199-201 (June, 1960).

The importance of tilting and rotating the specimen in electron microscopy and electron diffraction is discussed. The design and construction of a specimen stage, allowing a maximum tilt of 35 deg. of the plane of the specimen from a plane perpendicular to the electron beam, and providing a 360 deg. rotation at all angles of tilt are described. Though the stage has been designed specifically for the Metropolitan-Vickers type E.M.3 electron microscope, the principles involved may have application to other microscopes.

539.27

10341 A SIMPLE METHOD FOR OBTAINING PERFORATED SUPPORTING MEMBRANES FOR ELECTRON MICROSCOPY. V.Drahoš and A.Delong.
Nature (London), Vol. 186, 104 (April 2, 1960).

A clean glass slide is dipped into a 0.2% collodion–isoamylacetate solution and held for 30 sec in a vertical position above the solution surface. It is removed and quickly breathed on at intervals of a few seconds. The perforated film is detached using a water surface and mounted on specimen grids for carbon evaporation.
R.Reed

539.27

10342 THE ELECTRON MICROSCOPE PREPARATION OF CATHODE FILMS. R.Weiner and C.Schiele.
Naturwissenschaften, Vol. 47, No. 6, 130-1 (1960). In German.

The cathode surface is carefully rinsed free from electrolyte by washing in pure acetone. A thin Formvar film is then applied followed by a backing film of polyvinyl alcohol. After dry stripping, the backing is removed by distilled water, leaving the cathode film embedded in Formvar, ready for examination.
R.Reed

539.27

10343 AN ELECTRON MICROSCOPE STUDY OF SYNTHETIC GRAPHITE. I.M.Dawson and E.A.C.Follett.
Proc. Roy. Soc. A, Vol. 253, 390-402 (Dec. 15, 1959).

The ultra-microtome was used to obtain thin sections of synthetic graphite blocks. The thickness of the sections was measured by shadowcasting and measuring the shadow length at appropriate edges. An average value of 150 A was obtained. Transmission electron micrographs of thin sections showed moire patterns and the interrelation of these moire patterns revealed a characteristic grain structure in graphite akin to that seen in metals but with component microcrystals of smaller dimensions. The area of the individual microcrystals forming the grain structure was measured and was found to be 0.11 ± 0.074 μ^2. The boundary between neighbouring microcrystals was narrow and of around 50 A in width. Pores were visible at the junction of three or more contiguous microcrystals and were of diameter 400 to 800 A. The selected-area electron diffraction technique was used to determine the orientation of individual microcrystals in the graphite sections. It was found that the hexagonal layer net planes were lying parallel or at a very small angle to the plane of the section. The electron diffraction patterns were also used to correlate the layer stacking faults in individual microcrystals both by counts of individual reflections on the (1120) diffraction ring and by counts of the extra reflections due to the long spacings between successive displaced layers. The average value of 13 A found for the distance between successive stacking faults is equivalent to the distance between four hexagonal layer net planes. The moire patterns in the electron micrographs

could be related to the long spacings in the electron diffraction patterns. It was possible to calculate the angle of twist between successive stacking faults from the long spacing or from the moire pattern. Dislocations were seen in many of the thin sections and were observed as extra terminating half-lines in the moire patterns; these dislocations were present in the hexagonal layer net planes themselves and indicated that there was in this region a considerable deformation of the benzenoid structure of the hexagonal layer nets. The measured frequency for their occurrence was $3.3 \times 10^7/cm^2$. Slip planes were also detected in some specimens.

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

541.12

10344 INTERACTION BETWEEN CHAINS IN COMPLEX CHAIN PROCESSES. V.F.Tsepalov.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 571-4 (Sept. 21, 1959). In Russian.

Deals with the solution of the general problem of the kinetics of a chain reaction in a complex mixture, which would be applicable to reactions of copolymerization, oxidation, cracking etc.

F.Lachman

541.12

10345 ON THE ORIGIN OF THE PRE-SORPTIVE EFFECT AND CERTAIN OTHER ANOMALIES IN THE CATALYTIC OXIDATION OF CO ON OXIDE SEMICONDUCTORS. S.Z.Roginskii. Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 122-5 (Jan.1, 1960). In Russian.

A general discussion of implications and applicability of band theory. The close connection between catalytic activity and activated adsorption of CO is pointed out. The latter lowers the work function (ϕ) while oxygen raises it; mixtures of CO + O_2 give an intermediate effect. Oxygen, on the band model, reduces bending of the bands at the surface; this should decrease the free energy of formation of positively charged intermediate surface complexes, e.g. $CO^+ . H_2O$ bends the bands in the opposite sense, like CO, and so reduces catalytic activity, particularly as it is strongly absorbed. Similar behaviour is to be expected from other molecules capable of donating electrons when adsorbed. Theoretically catalysis should be enhanced if the semiconductor contains impurities lowering ϕ, and vice versa. This is usually found to be the case, but the thermal activation energy for electric conduction does not always vary correspondingly; this can be explained as due to changes in the reaction rate limiting step. The role of oxygen saturation of active sites on reaction kinetics is briefly discussed. See also Abstr. 5472 of 1956; 7875 of 1957.

C.H.L.Goodman

541.12

10346 THE ORIGIN OF THE COMPENSATION EFFECT IN CHEMICAL KINETICS. S.Z.Roginskii and Yu.L.Khait. Dokl. Akad. Nauk SSSR, Vol. 130, No. 2, 366-9 (Jan. 11, 1960). In Russian.

An attempt at providing the explanation of the exponential relation $\ln k_0 = \text{const} + \beta E$, found by a number of authors to exist between the coefficients of the Arrhenius equation $k = k_0 \exp(-E/kT)$.

F.Lachman

541.12

10347 INTERMOLECULAR ISOTOPE EFFECT IN RECOIL TRITIUM REACTIONS WITH HYDROGEN. J.K.Lee, B.Musgrave and F.S.Rowland. J.chem. Phys., Vol. 32, No. 4, 1266-7 (April, 1960).

Recoiling tritium atoms from the nuclear reaction $He^3(n,p)T$ show a preference for formation of HT over DT in reaction with mixtures of H_2 and D_2. Factors which cause this preferential reaction are discussed.

G.I.W.Llewelyn

541.12

10348 COMPUTATION OF THE EQUILIBRIUM COMPOSITION OF BURNT GASES. R.L.Potter and W.Vanderkulk. J. chem. Phys., Vol. 32, No. 5, 1304-7 (May, 1960).

The multicomponent chemical equilibrium composition problem is discussed generally and a formulation of it is presented in a form suitable for digital computer calculations. A geometric interpretation of the equations used to specify the chemical system is also given.

541.12

10349 THERMAL DECOMPOSITION OF NIOBIUM AND TANTALUM MONOCARBIDES. C.P.Kempter and M.R.Nadler. J. chem. Phys., Vol. 32, No. 5, 1477-81 (May, 1960).

The thermal decomposition of polycrystalline NbC was investigated from 2000° to 3200°C, and TaC from 1890° to 3320°C in the presence of one atmosphere of helium. It was found that both compounds lose carbon preferentially, and that the final carbon/metal molar ratio obtained may be represented by an equation of the form $C/M = A - B \exp(\lambda t)$, where t is the maximum temperature of heating for a constant time (30 min in both cases). Similarly, the resultant lattice constant may be expressed as $a_0 = A' - B' \exp(\lambda t)$, where a_0 is in A at 25°C. For a maximum temperature of 3000°C and heating times of 30 min to 12 hr, $a_0 = 4.459084 + 0.0093071 \exp(-0.18916\ \tau)$ for NbC, where τ is the time in hours. It was found that $a_0 = 4.414712 + 0.056862$ (C/Nb) for the C/Nb range 0.885 to 0.981 and that $a_0 = 4.385779 + 0.070204$ (C/Ta) for the C/Ta range 0.906 to 0.996. By extrapolation, the lattice constants of stoichiometric NbC and TaC should be 4.47157 ± 0.00012 A at 25°C and 4.45598 ± 0.00038 A at 25°C, respectively.

541.12

10350 KINETICS OF UNIMOLECULAR DECOMPOSITION OF EXCITED ALKYLAMINE IONS. W.A.Chupka and J.Berkowitz. J. chem. Phys., Vol. 32, No. 5, 1546-53 (May, 1960).

The unimolecular reaction $RCH_2NH_2^+ \rightarrow R + CH_2NH_2^+$ was studied for the n-alkylamines from ethyl- to n-heptylamine inclusive by a mass spectrometric technique. The intensity of the metastable ion produced in this reaction was measured and used to determine the variation of the specific rate constant with the internal energy of the molecular ion. The results are compared with those predicted by various theories. The agreement of the data with the theories of Kassel and of Rosenstock is bad for the smallest molecules but improves with increasing number of oscillators in the molecule. Earlier evidence for intramolecular vibrational relaxation in the parent molecular ions is discussed in relation to the assumptions of Slater's theory. A simplified application of Slater's theory seems to explain all the data.

541.12 : 534.22

10351 INVESTIGATION OF DETONATION WAVE PRESSURE BY THE METHOD OF CRUSHER ROD COMPRESSION. S.M.Kogarko. Zh. tekh. Fiz., Vol. 29, No. 1, 128-40 (Jan., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 1, 113-22 (Jan., 1959).

In measurements of the maximum detonation pressure by means of a piston which crushes a calibrated cuprite rod, it is shown how the recorded pressure depends on the mass of the piston. The response time is between 5×10^{-9} and 1.2×10^{-8} sec which is at least 50 times too large. Experiments with hydrogen–air mixtures were briefly reported in an earlier paper [S.M.Kogarko and Ya. Ya.B.Zel'dovich, Dokl. Akad. Nauk. SSSR, Vol. 63, 553 (1948)]. In limit methane–air or hydrogen–air mixtures the pressure measured in the reaction zone is greater than at the Jouguet point in the reaction products. A pressure about twice that calculated for the Jouguet point is measured in the reflected wave in a limit methane–air mixture and in the travelling wave in limit mixtures of methane–air or benzene–air.

E.R.Wooding

541.12 : 539.2

STATISTICAL FORMULATION OF CHEMICAL REACTIONS BETWEEN DEFECT PARTICLES IN CUBIC CRYSTAL LATTICES. See Abstr. 9892

ELECTROCHEMISTRY

541.13 : 621.317.61 : 621.352

10352 CHARACTERISTICS CURVES FOR THE ELECTRICAL RESISTANCE OF GALVANIC CELLS. J.Euler.
Abhandl. Braunschw. Wiss. Gesell., Vol. 11, 67-81 (1959). In German.

A.C. measurements, using a special bridge, were made on galvanic cells. The bridge can be used at frequencies from 10 c/s to 100 kc/s for measurements up to 1000 μF and 100 mhos. The values obtained for the capacitive and real components of apparent conductivity of the cells are transformed into the corresponding values of resistance. By plotting these in rectangular coordinates the Argard diagram is obtained. Fine-element equivalent circuits are then prepared which enable a simplified but adequate picture of the internal processes of the cell to be built up; both at the electrodes and within the electrolyte.

541.13

10353 ON THE CHARACTERISTICS OF ELECTROCHEMICAL SOLUTION OF N-TYPE SILICON.
E.A.Efimov and I.G.Erusalimchik.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 2, 353-5 (Jan. 11, 1960). In Russian.

Reports measurements of the anode polarization in an electrochemical solution of Si at current densities of 10^{-6} to 5×10^{-4} A/cm^2 in 2.5 N HF at 20° C. Thickness of the n-type region between the p-type region and the electrolyte was 20-25 μ. Variation with thickness and resistivity shows that the necessary holes are mainly generated in the space charge region at the boundary with the electrolyte [for Ge, they come from the bulk of the material, e.g. Abstr. 4104B of 1956; J. Electrochem. Soc., Vol. 103, No. 4, 252-6 (April, 1956)]. R.Berman

541.13

10354 THERMODYNAMIC PROPERTIES OF INDIUM ANTIMONIDE.
A.V.Nikol'skaya, V.A.Geiderikh and Ya.I.Gerasimov.
Dokl.Akad. Nauk SSSR, Vol. 130, No. 5, 1074-7 (Feb. 11, 1960). In Russian.

The following magnitudes have been calculated from the experimentally determined e.m.f. of the concentration cells In(liq)|(KCl-LiCl) + InCl|(Insb + Sb) (solid): $-\Delta H_{723} = 3.98$ kcal/g atom, $-\Delta H_{298} = 3.67$ kcal/g atom, $-\Delta Z_{298} = 3.07$ kcal/g atom, and $-\Delta S_{298} = 2.01$ cal/g atom deg. F.Laci.

541.13 : 532.6

10355 ZERO-CHARGE POTENTIALS IN Te–Tl ALLOYS.
V.A.Kuznetsov, V.I.Aksenov and M.P.Klevtsova.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 4, 763-6 (Oct. 1, 1959). In Russian.

Using the method described in an earlier paper [Kuznetsov at al., Dokl. Akad. Nauk SSSR, Vol. 92, 1197 (1953)], electro-capillary curves of Te, Tl and their alloys were obtained at 475° C (electrolyte: the LiCl–KCl eutectic; the potentials measured with respect to a molten Pb electrode). Up to about 25%, the addition of Tl to Te caused a decrease of the interphase surface tension, while further additions increased the surface tension. As the Tl content increases, the zero-charge potential shifts towards negative values. This behaviour is explained both qualitatively and quantitatively.
F.Lachman

PHOTOCHEMISTRY
RADIATION CHEMISTRY

541.14

10356 PHOTOCHEMICAL PHENOMENA IN SENSITIZED AgCl CRYSTALS AT A TEMPERATURE OF –253° C.
A.Scholz.
Ann. Phys. (Leipzig), Folge 7 , Vol. 3, No. 5-6, 298-315 (1959). In German.

Sensitized AgCl crystals, even at the temperature of liquid hydrogen and lower become coloured as a result of irradiation. The photochemical sensitivity decreases with decreasing temperature. Prior irradiation at –185° C and bleaching out of the resulting colour produces increased photochemical sensitivity at –253° C. The colouring is explained by the suggestion that a sufficient number of Ag_o^+-ions are situated in the immediate neighbourhood of electron traps. W.Good

541.14

10357 A STUDY OF THE MECHANISM OF PHOTOCHEMICAL ELECTRON TRANSFER PROCESSES IN SOLUTION.
F.H.C.Edgecombe and R.G.W.Norrish.
Proc. Roy. Soc. A, Vol. 253, 154-62 (Nov. 24, 1959).

The flash photolysis of halide solutions yields unstable species believed to be the dihalide ion, the absorption spectrum of which was observed and photographed. This transient was noted during the photolysis of (a) the aqueous solutions of KCl, KBr, KI, HCl, NaCl. NaBr, NH_4Cl, $MgCl_2$, $HgCl_2$, $CaCl_2$ and $SrCl_2$; (b) the ethyl and methyl alcoholic solutions of KBr and KI; (c) the methyl cyanide solution of KI. The effect of the addition of sulphuric acid, potassium hydroxide and Mn^{2+} ion to certain of the solutions was also studied. The authors' interpretation of the results of the flash photolysis of KI in solution, based on the Rigg and Weiss mechanism of electron transfer, involves the postulation of the splitting of the solvent molecule. In water solution, this would mean the formation of hydrogen. The production of hydrogen in aqueous solutions of KI of pH 6 to 7 was confirmed by an investigation of the steady state photolysis.

541.14

10358 POLARIZABILITY AND HALF-LIFE OF OPTICAL SENSITIZERS. M.Wilk.
Z. Elektrochem., Vol. 64, No. 2, 294-6 (1960). In German.

Chromatographic and photoconductivity measurements on dyestuffs used to sensitize silver bromide to red radiation are reported. Possible mechanisms for the reaction are discussed. J.M.Hough

541.15

10359 RADIATION-INDUCED CHANGES IN THE STRUCTURE OF POLYPROPYLENE. R.M.Black and B.J.Lyons.
Proc. Roy. Soc. A, Vol. 253, 322-30 (Dec. 15, 1959).

Polypropylene undergoes both cross-linking and random main-chain fracture when exposed to high-energy radiation, the ratio of cross-linking to chain fracture varying with the dose received up to the gel point. An examination of the infrared absorption spectrum of the irradiated polymer has shown that, in addition, vinylidine unsaturation (R.R'C=CH) is formed in the ratio of one vinylidene double bond to each chain fracture. The rate of main-chain fracture deduced from intrinsic viscosity measurements has been found to be initially (up to a dose of 35 Mrad) a function of the number of chain fractures produced, rather than proportional to the intensity of the radiation, as might have been expected from the behaviour of other polymers. After a dose of 50 to 60 Mrad an insoluble cross-linked gel can be separated from the polymer by solvent extraction, and the sol fraction decreases on further irradiation in accordance with the theoretical expression derived by Charlesby (1953), assuming that for every cross-link formed, one bond between two monomer units is broken. A mechanism for the radiation-induced changes is proposed, based upon the application of classical chemical kinetics, which is in good agreement with the observed phenomena.

DISPERSIONS . COLLOIDS
ADSORPTION

541.18

10360 ACTION OF A UNIFORM ELECTROSTATIC FIELD UPON THE ORIENTATION OF ALUMINIUM FLAKES WHICH ARE SUSPENDED IN A GAS.
J.M.Bourot, R.Brun and B.Morillon.
C.R.Acad. Sci. (Paris), Vol. 250, No. 12, 2118-20 (March 21, 1960). In French.

A uniform electrostatic field of the order of 1000 V/cm can be applied to orientate aluminium flakes suspended in an air stream so as to counteract any flow orientation of the particles.
R.Schnurmann

541.18 : 537.2

10361 CHARGE OF SUBMICRONIC PARTICLES IN IONIZED ELECTRIC FIELDS. MEASUREMENT OF THE SPEED OF PRECIPITATION OF THESE PARTICLES IN A UNIFORM

ELECTRIC FIELD. R.Cochet.
C.R.Acad.Sci. (Paris), Vol. 250, No. 12, 2164-6 (March 21, 1960). In French.

Experimental verification of a previously described theory (Abstr. 1265 of 1957). An aerosol with particle sizes between 0.02 and 0.5 μ radius was entrained in an electric field across an ion beam. The precipitated globules were measured with an electron microscope. In the early stages of precipitation large and small particles (0.5 μ and 0.05 μ) were found. The end of the precipitation pattern showed only particles of the order of 0.1 μ. For electric fields between 1500 and 5000 V/cm, the mean free path of the ions was $l_i = l_g\sqrt{2}$. R.Schnurmann

541.18

10362 EFFECT OF AMBIENT AIR SPEED ON EFFICIENCY OF THERMAL-PRECIPITATOR.
J.R.Hodkinson, A.Critchlow and N.Stanley.
J. sci. Instrum., Vol. 37, No. 5, 182-3 (May, 1960).

Within the air speed range of 40-1200 ft/min. no significant variation in the sampling of 1-5 μ particles with a thermal precipitator sampling moving air, compared to one sampling stationary air, was obtained. R.Schnurmann

541.18

10363 BALLISTIC PARTICLE SIZE SEPARATOR.
J.H.McGinn and J.T.MacWaters.
Rev. sci. Instrum., Vol. 31, No. 5, 513-16 (May, 1960).

A new type of instrument for the size classification of airborne particulate matter is described. This apparatus operates on an aerodynamic principle and effects ordered size separation of both liquid and solid particles. Calculations of the spatial separation as a function of size for spherical particles of unit density are in accord with preliminary experimental data for diameters between 10 and 100 μ. Application of this principle to aerosol size-frequency analyses is discussed briefly.

541.18

10364 A SIMPLE GENERATOR FOR THE PRODUCTION OF MONODISPERSE AEROSOLS IN THE DIMENSIONAL RANGE 0.15 - 0.7 μ (PARTICLE RADIUS). L.Lassen.
Z. angew. Phys., Vol. 12, No. 4, 157-9 (April, 1960). In German.

A simple apparatus is described, based on a La Mer-type of atomizer [cf. La Mer and Sinclair, Chemical Reviews, Vol. 44, 245 (1949)], for the production of monodisperse dioctyl phthalate (DOP-mist). The mode of working is given for a rate of production of about 10-20 litre/min of particle concentrations of about 10^8 - 10^7 cm^{-3}. 5 references. H.H.Hodgson

541.18

10365 THE COAGULATION OF AEROSOLS BY FREE-FLOWING GAS JETS. P.N.Kubanskii.
Zh. tekh. Fiz., Vol. 29, No. 9, 1140-1 (Sept., 1959). In Russian.
English translation in : Soviet Physics – Technical Physics (New York), Vol. 4, No. 9, 1041-2 (March, 1960).

Combustion in the flame zone of steam boilers is improved by a so-called "sharp" blast, when air is delivered through a nozzle into the combustion zone with a velocity of 50-70 m/sec. The coagulation of aerosols takes place as the result of ultrasonic oscillations created by the air jets. It is suggested that the diameters of the nozzles should be reduced to 2-3 mm. R.Schnurmann

541.18

10366 SEDIMENTATION AND EFFECTIVE VISCOSITY.
D.R.Oliver; G.J.Kynch.
Nature (London), Vol. 185, 912-13, 913-14 (March 26, 1960).

Kynch's theoretical formula (Abstr. 4740 of 1960) relating sedimentation rate, effective viscosity of a suspension and concentration agrees less well with experiment than some simple empirical formulae. The discrepancy is worst for nearly equi-sized (spherical) particles in suspension, and is attributed to the neglect, in the theory, of the effect of the pressure gradient due to sedimenting particles. J.G.Oldroyd

541.18

10367 A CONTRIBUTION TO THE THEORY OF CHEMICAL ADSORPTION. V.I.Osherov.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 117-19 (Jan. 1, 1960). In Russian.

An attempt is made at applying directly Bloch's functions to describe the crystal-adsorbent system in order to generalize the method of localized states in molecules and crystals, used in recent papers. F.Lachman

541.18

10368 CHEMISORPTION OF OXYGEN ON GERMANIUM.
R.Kh.Burshtein, L.A.Larin and G.F.Voronina.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 4, 801-3 (Feb. 1, 1960). In Russian.

Ge powder obtained by the comminution of monocrystals (specific surface 620 cm^2g^{-1}) was first freed from oxide films by repeated reduction in H_2 (1-2 hours at 400-450°C) and then degassed several times at 10^{-7} mm Hg and finally at 10^{-9} mm Hg at the same temperature. The method used for studying the following adsorption of O was the same as that described in papers by Burshtein et al. [Zhurnal Fizicheskoi Khimii, Vol. 20, 789 (1946)] and by Rideal and Trappnel (Abstr. 3876 of 1951). Two stages of O adsorption on Ge are shown to exist: a fast and a slow one, the amount of the slowly adsorbed O being equal to that of the O adsorbed in the fast process. It is suggested that the former stage is consistent with the reaction $2Ge + O_2 \rightarrow 2GeO$, and the latter stage with the reaction $2GeO + O_2 \rightarrow 2GeO_2$. F.Lachman

541.18

10369 INFLUENCE OF THE MOLECULAR OR ATOMIC NATURE OF THE SURFACE LAYER OF A SOLID WALL ON THE INTERACTION BETWEEN INCIDENT GAS MOLECULES AND THE WALL. A.Nikuradse and K.Kugler.
Forschungsber. Wirtsch. Nordrhein-Westfalen, No. 595, 15 pp. (1958). In German.

Measurements of the amounts and rates of adsorption of gaseous chlorine on freshly scraped copper and on copper covered with thin oxide films are described. The apparatus is described and illustrated and the results are shown graphically as a function of time. S.Weintroub

541.18

10370 INTERACTIONS BETWEEN MOLECULES ADSORBED ON A SURFACE. O.Sinanoğlu and K.S.Pitzer.
J. chem. Phys., Vol. 32, No. 5, 1279-88 (May, 1960).

The intermolecular potential energy between two inert gas molecules is considerably altered when these molecules are next to a solid surface as in physical adsorption. The change in the interaction is evidenced by the additional long range repulsion that is often observed between the molecules of a monolayer and also by the additional attractions that must play a role in multilayer formation In this paper, the two-molecule-surface potential is derived from quantum mechanical third-order perturbation theory. It is shown that this potential consists of two parts just as the energy giving the van der Waals attraction of a single molecule to a surface does. The first part exists only when the surface has a net electrostatic field and this is equivalent to the classical polarization effect. The second part arises from the fluctuations of the surface fields and is of the same origin as the dispersion forces. The third-order energy, i.e., the new intermolecular interaction caused by the surface, is directly related to the zero-coverage heat of adsorption and except for this experimental quantity, the results do not require specific assumptions about the surface. Thus, the theory is applicable to either metal or insulator surfaces When both the two-molecule-surface and the one-molecule-surface interactions are available experimentally (for example, from the application of virial coefficients treatment in physical adsorption) the electrostatic field of the surface can be estimated. The fluctuation or dispersion part of the third-order energy is shown to yield a repulsion between two molecules in a monolayer that amounts to 20-40% of the gas phase Lennard Jones potential minimum ϵ_0. The same energy yields an additional attraction of about 10-20% of ϵ_0 when the two molecules are on top of one another as in multilayer formation. The theory is applicable also when more than two molecules at a time need be considered on the surface.

541.18

10371 THE EFFECT OF THE SPREADING SOLVENT ON THE PROPERTIES OF MONOLAYERS.
M.L.Robbins and V.K.La Mer.
J. Colloid Sci., Vol. 15, No. 2, 123-54 (April, 1960).

The effects produced by benzene or hexane as spreading solvents upon the surface pressure-area isotherms of octadecanol and stearic acid were investigated. Diluting the spreading solution resulted in an increase in the area/molecule at π = 1 dyne/cm. This expansion was

greater with hexane than with benzene. Monolayers of stearic acid expanded more than those of octadecanol upon adding benzene liquid or vapour to the surface. Benzene vapour was irreversibly adsorbed on a monolayer of stearic acid. Octadecanol monolayers expanded when the concentration of benzene in the subphase was increased. An expansion of the monolayer with age was noted. This effect was greater for octadecanol than stearic acid monolayers. Ageing could be attributed to changes in the structure of the monolayer as well as to contamination. Expansions resulting from both ageing and solvent effects were greater at low surface pressures. A model based on the relative rates of solvent evaporation and diffusion into the subphase during the spreading process is proposed. The surface concentrations of benzene evaluated from experimental data and the model are compared. The two values agree within a factor of three.

541.18

10372 ORIENTATION OF STEARIC ACID MONOLAYERS ON SILVER SINGLE CRYSTALS. R.T.Mathieson.
Nature (London), Vol. 186, 301-2 (April 23, 1960).

Monolayers absorbed by retraction from n-hexadecane solutions on the flat (111) face of a single crystal, have a regular lateral arrangement of molecules. The individual patches take up one of three orientations consistent with the threefold symmetry of the 111 face, while the hydrocarbon chains are normal to the face.

R.Reed

541.18

10373 PULSED MASS-SPECTROGRAPH INVESTIGATION OF DESORPTION OF HYDROGEN AND DEUTERIUM FROM PALLADIUM. Yu.I.Belyakov and N.I.Ionov.
Zh. tekh. Fiz., Vol. 30, No. 2, 216-22 (Feb., 1960). In Russian.

Tests, carried out with the aid of a high-sensitivity (10^{-12} A/cm^2), pulsed mass spectrograph, showed that H, diffused at 0-120 mm Hg pressure through a Pd membrane at 80-750°C, did not contain any positive or negative H ions. H, diffused through Pd and desorbed from its hot surface, contained no more than 1% atomic H. An equi-molecular mixture of H and D, diffused through Pd, contained HD molecules, the proportion of which was in conformity with the law of random processes.

M.H.Sloboda

541.18 : 533.5

10374 SORPTION OF ACTIVATED GASES BY TITANIUM FILMS. L.Holland.
Nature (London), Vol. 185, 911-12 (March 26, 1960).

Experiments are described on the increased rates of sorption by Ti films when the gas is ionized by a Penning gauge.

A.H.W.Beck

541.18 : 539.19

10375 INFRA-RED STUDIES OF WATER ADSORBED ON ALKALI HALIDES.
W.C.Price, W.F.Sherman and G.R.Wilkinson.
Proc. Roy. Soc. A, Vol. 247, 467-8 (Oct. 21, 1958).

Thin films of adsorbed water on alkali halides AB (A = Na, K, Rb or Cs, B = Cl, Br or I) in the form of pressed disks were examined spectroscopically. The frequency of the strongest band in the 3000-3500 cm^{-1} region indicates that the water is attached by hydrogen bonding to the negative ions. The absorption spectrum for a thin layer of water on a CsI disk between 2700 and 3800 cm^{-1}, at 20°C and -186°C is reproduced.

R.F.S.Hearmon

541.18 : 539.19

10376 A NOTE ON THE THERMODYNAMIC PROPERTIES AND INFRA-RED SPECTRA OF SORBED WATER.
G.J.C.Frohnsdorff and G.L.Kington.
Proc. Roy. Soc. A, Vol. 247, 469-72 (Oct. 21, 1958).

The behaviour of the 3μ and 6μ infra-red absorption bands of water sorbed on a synthetic zeolite is investigated as a function of water content and the results interpreted in terms of the bonding between the zeolite and water.

R.F.S.Hearmon

541.18 : 537.533

ADSORPTION PROPERTIES OF AN ATOMIC BARIUM FILM ON THE SURFACE OF OXYGEN-COATED TUNGSTEN.
See Abstr. 9064

PHYSICAL METHODS OF CHEMICAL ANALYSIS

545

10377 EXPLANATION OF CERTAIN TYPES OF CURVES OBTAINABLE IN HIGH FREQUENCY TITRATIONS.
A.Bellomo and E.Bruno.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 5, No. 4, 459-470 (1958-59) In Italian.

Previous measures taken to eliminate non-reproducibility of diagrams have failed, and no explanation of the causes has been found. The authors have previously stressed the importance of the method of calibration, which consists in setting the oscillator to maximum or minimum values of current, according to the electrode at which the measurements are made, by means of the tuning capacitor in parallel with the cell. The introduction of an electrolytic solution into the capacitor causes a change in the Q. The results of experiments with different solutions are given in a series of current and frequency curves. They reveal that the amplitude of the frequency variations is inversely proportional to the capacitance coupled in the cell. Using a quartz crystal oscillator with fine and coarse regulating capacitors across the cell, the authors found only a few cases of curves differing from the theoretical, and these were reproducible in form.

W.G.Stripp

545

10378 MUTUAL SPECTROSCOPIC INFLUENCES IN SOLUTIONS OF THE ELEMENTS Fe, Ni, Cr, Ti TAKEN THREE BY THREE. G.Baudin and M.Vo-Dinh.
C.R.Acad. Sci. (Paris), Vol. 250, No. 10, 1818-20 (March 7, 1960). In French.

In a solution of two of the elements in a third, the curves $\Delta C_X/C_X = f(C_Y)$ obtained by varying one of the two show a linear relationship. These lines are parallel and show the additivity of the influences.

G.H.C.Freeman

545

10379 COMPENSATED WHEATSTONE'S BRIDGE CIRCUIT FOR GAS-CHROMATOGRAPHIC CATHAROMETRY.
A.B.Littlewood.
J. sci. Instrum., Vol. 37, No. 6, 185-8 (June, 1960).

Drift of the base line caused by imperfect control of temperature or voltage of a gas-chromatographic catharometer may be eliminated by including one shunt and one series resistance with the catharometer hot elements in the Wheatstone's bridge circuit. Equations enabling the positions and values of the resistances to be calculated from the observed drift are given. Experience shows that use of the compensating resistances enables a catharometer to be used more sensitively without the trouble and expense of careful temperature and voltage control.

545

10380 SELECTIVE MODULATION OF RADIATION BY PERIODIC VARIATION OF GAS TEMPERATURE.
A.O.Sall'.
Optika i Spektrosk., Vol. 7, No. 4, 576 (Oct., 1959). In Russian.

Selectivity of sources used in optico-acoustic gas analysers (chambers filled with an appropriate gas) is reduced by emission of the window and the walls of the chamber. To avoid the effect of this emission the gas temperature should be varied periodically (for example by alternate compression and rarefaction of the gas) without altering to any great extent the temperature of the window and the walls of the chamber. Using only the modulated radiation beam, the effect of the window and the walls is very considerably reduced. These ideas were verified experimentally using carbon dioxide gas.

A.Tybulewicz

GEOPHYSICS

550.3

10381 SOME CONSEQUENCES OF EXPANSION OF THE EARTH. J.T.Wilson.
Nature (London), Vol. 185, 880-2 (March 26, 1960).
The paper discusses geological and geophysical evidence bearing upon any change in size of the earth. 30 references.
E.G.Knowles

550.3 : 534.2

10382 OBSERVATIONS OF THE DEVELOPMENT OF RAYLEIGH-TYPE WAVES IN THE VICINITY OF SMALL EXPLOSIONS. C.Kisslinger.
J. geophys. Res., Vol. 64, No. 4, 429-36 (April, 1959).
Study of the particle motion and dispersive properties of waves generated by small explosions has led to the identification of the fundamental M_2 mode and possibly a higher mode of this branch of the solution of the Rayleigh wave equation. In the particular field models, consisting of loess and clay over limestone, variations in near-surface conditions at the source have a greater effect on the recorded motion than do similar variations at the recording sites. The features within the complex motion close to the source can be identified with specific wave types, which are well-separated at the larger distances.

550.3

10383 UNDERGROUND NUCLEAR DETONATIONS. G.W.Johnson, G.H.Higgins and C.E.Violet.
J. geophys. Res., Vol. 64, No. 10, 1457-70 (Oct., 1959).
Since 1952 eight nuclear explosions have been fired underground at the Atomic Energy Commission's Nevada Test Site. The explosions varied in energy release from 55 tons to 19 000 tons of TNT equivalent. Depths of burial varied from shallow, to produce cratering, to deep, where no visible effects appeared on the surface. The major experimental data from these explosions, as well as the phenomenology of the deeper shots, are summarized here.

550.3

10384 SURFACE MOTION FROM LARGE UNDERGROUND EXPLOSIONS. D.S.Carder and W.K.Cloud.
J. geophys. Res., Vol. 64, No. 10, 1471-87 (Oct., 1959).
Seismic effects of several underground nuclear explosions were measured in terms of ground surface motion by suitable seismographs from 1200 ft to nearly 10 miles from the source and with teleseismic instruments at great distances. Prior to the Rainier explosion (a 1.7 kt nuclear shot detonated 900 ft underground) empirical formulae were developed which predicted ground effects from the Rainer shot and several of the larger HARDTACK II shots with fair accuracy but with certain limitations. The limitations were (1) that at distances greater than a few thousand feet, observed displacements were somewhat larger than the formula predicted, necessitating revision of the formula; (2) that frequencies of ground waves did not exceed 20 c/s; and (3) that the source conditions and material were in fair duplication. Ground amplitudes on deep alluvium were, as expected, more than twice the amplitudes at nearly the same distance on rock. Velocity response spectrums of one of the shots have been made and reproduced. The magnitude of the Rainier shot was about 4.0, based on the assumption that the source was contained in a volume of rock comparable to that of an earthquake having the same magnitude. Local travel-time data indicate that the subbasement rock associated with a speed of about 6.2 km/sec is about 3600 ft beneath the shot points area.

550.3

10385 AMPLITUDES OF SEISMIC BODY WAVES FROM UNDERGROUND NUCLEAR EXPLOSIONS. C.Romney.
J. geophys. Res., Vol. 64, No. 10, 1489-98 (Oct., 1959).
Seismic waves from underground nuclear explosions in Nevada were observed at a number of temporary stations along a line extending eastward to Maine. A study of the seismograms from these stations and from a large number of permanent stations has shown that the amplitude of Pn varies inversely as the cube of the distance between 200 and 1100 km. Pn then disappears and a late-arriving higher velocity wave appears with relatively large amplitude. This later P wave has a slight amplitude maximum at about 2000 km, after which it decreases irregularly with distance. Between 200 and 2000 km the amplitude of S (or Lg) varies inversely as the cube of the distance. The vertical, radial, and transverse components are of approximately equal size, and are about three times the amplitude of Pn between 200 and 1000 km. At distances of 100 km or more the amplitudes of the body waves are proportional to the first power of the explosive yield. The explosions produced seismic waves equivalent in size to those from natural earthquakes of magnitude: $M = 3.65 + \log Y$, where Y is the energy of the explosion expressed in kilotons of TNT equivalent.

550.3

10386 LOW-VELOCITY LAYERS IN THE EARTH, OCEAN, AND ATMOSPHERE. B.Gutenberg.
Science, Vol. 131, 959-65 (April 1, 1960).
Review paper. The layers increase the difficulty of locating buried explosions and may cause sonar booms.

550.3 : 532.5

10387 A HYDRODYNAMIC APPROACH TO THE "TSUNAMI" EFFECT. L.N.Sretenskii.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 273-4 (March 11, 1960). In Russian.
"Tsunami" waves are caused by underwater earthquakes in oceans. A method of solution of the wave equation is indicated by making use of Fourier transform integrals and of Riemann's method of integration for hyperbolic equations. J.K.Skwirzynski

550.3 : 534.2

ON THE ATTENUATION OF SMALL-AMPLITUDE PLANE STRESS WAVES IN A THERMOELASTIC SOLID. See Abstr. 8734

550.3 : 534.2

PLANE COMPRESSIONAL VOIGT WAVES. See Abstr. 8736

551.35 : 534.22

SOUND SPEED AND ABSORPTION STUDIES OF MARINE SEDIMENTS. See Abstr. 8739

550.3 : 535.3

METHOD FOR OBTAINING THE OPTICAL PROPERTIES OF LARGE BODIES OF WATER. See Abstr. 8766.

550.3 : 539.2 : 538.2

10388 EXCHANGE ANISOTROPY IN ROCK MAGNETISM. W.H.Meiklejohn and R.E.Carter.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 1648-1658 (May, 1960).
Some igneous rocks are magnetized in a direction opposite to that expected, if they had been cooled in the earth's magnetic field. These rocks are said to have a reverse thermo-remanent magnetization (reverse TRM). Uyeda has shown that the reverse TRM of the Haruna deposit in Japan is due to an ilmenite-hematite solid solution and has synthesized a solid solution that has a reverse TRM when cooled in fields as high as 16 000 Oe. He has put forth a theory which contains a mechanism similar to that found in the cobalt-cobaltous oxide system. Based upon Uyeda's explanation of the reverse TRM, it was postulated that the material should have a shifted hysteresis loop and that it should be shifted in the opposite direction to that found in the Co-CoO system. It was found that the solid solution — 0.6 $FeTiO_3$ 0.4 Fe_2O_3 — was shifted by 350 Oe in the opposite direction to Co-CoO when cooled in a field. The loop was symmetrical when cooled in zero field. It was also shown that when the material is cooled in a magnetic field through the Morin transition the loop is shifted in the same direction as Co-CoO. These results confirm the general features of Uyeda's model, although the detailed mechanism is still being studied. The authors believe that Uyeda's work definitely establishes the reverse TRM of the Haruna deposit as due to a magnetic phenomenon and not due to the reversal of the earth's magnetic field, and that the type of magnetic investigation reported in this paper may be applied to other deposits that have a reverse TRM to establish if they are also due to a magnetic phenomenon.

550.3

10389 PULSATIONS OF THE EARTH'S MAGNETIC FIELD AND EARTH CURRENTS. J.Coulomb.
Ann. Geofis., Vol. 12, No. 4, 461-87 (Oct.-Dec., 1959). In French.
A review of present knowledge relating to various types of magnetic pulsations. The nature and characteristic periods of the

pulsations are discussed, together with their temporal variations and dependence on solar activity. Different types are observed by day and by night in middle latitudes. Storm conditions and phenomena in the auroral zone are discussed separately. G.M.Brown

550.3

10390 EVIDENCE CONCERNING INSTABILITIES OF THE DISTANT GEOMAGNETIC FIELD: PIONEER I.
C.P.Sonett, D.L.Judge and J.M.Kelso.
J. geophys. Res., Vol. 64, No. 8, 941-3 (Aug., 1959).

The search-coil magnetometer carried on Pioneer I has yielded evidence of complex geomagnetic behaviour at great distances from the earth. Only preliminary observations are reported of what appears to be directional instability in the field. A comprehensive statistical analysis is to be reported.

550.3

10391 GEOMAGNETIC OSCILLATIONS AT MIDDLE LATITUDES. I. THE OBSERVATIONAL DATA. E.Maple.
J. geophys. Res., Vol. 64, No. 10, 1395-1404 (Oct., 1959).

Oscillations are defined as comprising only the more regular of the short-period geomagnetic fluctuations (periods from 1 to 200 seconds) and may be recognized as representing electromagnetic energy in narrow frequency bandwidths and identified by objective criteria. The characteristics of these oscillations, as indicated by the available observational data, are examined with a view toward the eventual identification of their resonant sources. Three distinct frequency "bands" are observed. Two of them, a 20 sec band (that is, oscillations having similar characteristics and having periods centred at about 20 sec) and a 70 sec band, are predominantly daytime phenomena, whereas the third, an 8 sec band, occurs at night. The 8 sec oscillations show a strong positive correlation, both in amplitude and duration, with the K index; this correlation is less pronounced for the 20 sec band and is absent (or perhaps negative) for the 70 sec band. An additional night-time band containing periods longer than about 95 sec is not yet definitely established

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10392 GEOMAGNETIC OSCILLATIONS AT MIDDLE LATITUDES. II. SOURCES OF THE OSCILLATIONS.
E.Maple.
J. geophys. Res., Vol. 64, No. 10, 1405-10 (Oct., 1959).

The observed characteristics of the oscillations, quasi-sinusoidal geomagnetic fluctuations having periods from 1 to 200 seconds, are compared with theories of their origins and with observations of other ionospheric phenomena. The results favour the hypothesis of intra-layer hydromagnetic resonance in the ionosphere as the source mechanism and suggest that the "daytime" oscillations comprising the 20 and 70 sec bands arise in the E region, whereas the "nighttime" 8 sec band originates in the F region. Simultaneous studies of the different phenomena are needed to confirm these results and to furnish data for comparisons with further developments of the theory.

550.3

10393 THE RELATIONSHIP BETWEEN GEOMAGNETIC VARIATIONS AND THE CIRCULATION AT 100 mb.
J.London, I.Ruff and L.J.Tick.
J. geophys. Res. Vol. 64, No. 11, 1827-33 (Nov., 1959).

Statistical methods are used to study the relationship, over a five-year period, between geomagnetic storms and the height gradients of the 100 mb surface over the United States. In the case of the superposed epoch analysis, the parameters studied were variations from population values of the mean height gradients and the standard deviation of the height gradients for the period 5 days before to 15 days following the geomagnetic storm. No pattern was found in the tested statistical significance at the 5% and 1% levels. The geomagnetic and height gradient spectra were constructed from the two time series and the coherency between the two series was computed. The coherency was found to be very small for all periods from 4 to 60 days. The conclusion is drawn that there is no obvious relationship between the two sets of data.

550.3 : 525

10394 CURRENT SYSTEMS IN THE VERTIGIAL GEOMAGNETIC FIELD: EXPLORER VI.
C.P.Sonett, E.J.Smith, D.L.Judge and P.J.Coleman, Jr.
Phys. Rev. Letters, Vol. 4, No. 4, 161-2 (Feb. 15, 1960).

Preliminary magnetometer data from satellite Explorer VI, giving the component magnetic field perpendicular to the spin axis of the vehicle, are compared with theoretical estimates. Reasonable agreement is obtained for distances less than about 5 earth radii, but beyond this, large scale deviations (sometimes positive, sometimes negative) occur. These suggest that the field is perturbed by the presence of extra-terrestrial currents in the region 5-7 earth radii. G.M.Brown

550.3 : 551.5

10395 STUDIES OF MAGNETIC FIELD MICROPULSATIONS WITH PERIODS OF 5 TO 30 SECONDS. W.H.Campbell.
J. geophys. Res., Vol. 64, No. 11, 1819-26 (Nov., 1959).

Magnetic field micropulsations with periods of 5 to 30 sec were studied for 7 months of 1958 at a station in southern California with a 2 m diameter coil antenna of 21 586 turns. The local diurnal amplitude fluctuation attained maxima at 0945 and 1400 hours. Twenty-seven-day solar dependence and correlations with magnetic and ionospheric F-layer disturbances were evident. The storm time variation for micropulsation storms showed a secondary maximum at 65 min.

550.3 : 523.16

SOLAR RADIO EMISSION OF SPECTRAL TYPE IV AND ITS ASSOCIATION WITH GEOMAGNETIC STORMS. See Abstr. 8475

550.3 : 538.3

TRANSMISSION OF GEOMAGNETIC DISTURBANCES THROUGH THE ATMOSPHERE AND INTERPLANETARY SPACE.
See Abstr. 9180

ATMOSPHERE . IONOSPHERE

(Abstracts on radiowave propagation in ionised media will also be found under Electromagnetic Waves)

551.5

10396 ACOUSTIC MICROANEMOMETER FOR INVESTIGATING THE MICROSTRUCTURE OF TURBULENCE.
A.S.Gurvich.
Akust. Zh., Vol. 5, No. 3, 368-9 (1959). In Russian. English translation in Soviet Physics—Acoustics (New York), Vol. 5, 375-7 (Feb., 1960).

The instrument uses cylindrical condenser transducers of 2 mm diameter and 5 mm working length for the microphones and radiators. The sensitivity of the microphones is 0.07 - 0.1 mV/bar at 75-100 kc/s and the base of the microanemometer is 2.5 cm. The overall sensitivity of the instrument is given as 9 cm/sec., and it is stated to have been used successfully for the measurement of the vertical component of the velocity of flow in the layer of atmosphere near to the earth's surface. S.Weintroub

551.5 : 525

10397 RADIATION MEASUREMENTS DURING THE FLIGHT OF THE SECOND COSMIC ROCKET.
S.N.Vernov, A.E.Chudakov, P.V.Vakulov, Yu.I.Logachev, and A.G.Nikolaev.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 3, 517-20 (Jan. 21, 1960). In Russian.

The apparatus used in the second Russian rocket, launched on 12 September 1959, is described. Some of the counters were mounted outside the container. Semiconductors were used. The results obtained are discussed under four headings: (1) data on the spatial distribution of the earth's external radiation belt; (2) the composition of the radiation in this zone; (3) a search for increased radiation near the moon (none discovered) and (4) measurement of cosmic-ray intensities. Comparisons are made with results from the first rocket and some theoretical explanation is included. G.A.Chisnall

551.5

10398 TRANSISTOR CUP ANEMOMETER.
R.R.McGregor.
J. sci. Instrum., Vol. 37, No. 6, 189-90 (June, 1960).

A remote indicating cup anemometer is described in which transistor electronics have been applied to obtain a compact instrument, operating off small dry batteries and capable of registering wind speeds down to 0.2 m/sec.

551.5 : 523.7

10399 LIGHTWEIGHT SUNTRACKER FOR BALLOON APPLICATIONS. M.L.Shechet.
Rev. sci. Instrum., Vol. 31, No. 5, 546-50 (May, 1960).

The entire tracking system including power supplies for a 12 hr flight weighs 1.76 kg. The system has demonstrated in the laboratory a capability of pointing a 1.42 kg load at the sun within ± 0.12°. A very simple and reliable acquisition and tracking technique is employed which uses no vacuum tubes or transistors.

551.5

10400 THE POSSIBLE OCCURRENCE OF NEGATIVE NITROGEN IONS IN THE ATMOSPHERE. F.D.Stacey.
J. geophys. Res., Vol. 64, No. 8, 979-81 (Aug., 1959).

Liquid conduction counter experiments give evidence of N_2^- ions, so that their possible occurrence in the atmosphere cannot be discounted. It is shown that a strong pressure dependence of electron–ion recombination coefficient, as found in laboratory experiments on nitrogen gas, would result from the formation of metastable negative ions. At very low pressures negative ion formation could result in an attachment law $-dn_e/dt = \beta n_e$ for decay of electron density n_e.

551.5

10401 ION-DENSITY MEASUREMENTS IN THE STRATOSPHERE. J.L.Kroening.
J. geophys. Res., Vol. 65, No. 1, 145-51 (Jan., 1960).

The number density of small negative ions in the atmosphere was measured in 1958 on a series of eight balloon flights which reached altitudes of 115 000 ft over Minneapolis (45°N). A pronounced decrease in the number density of small negative ions was observed at the tropopause on seven of the eight flights, and similar decreases were observed at numerous temperature inversions in the stratosphere. The results strongly suggest the presence and bunching of "dust" above the temperature inversions. In the absence of dust and ionizing agents other than cosmic rays, the number density of negative ions increases with altitude to 50 000 ft, where a maximum of approximately 5500 ions/cm³ occurs. Above this altitude the number density decreases to a value near 2000 ions/cm³ at 115 000 ft; this result is contrary to the almost constant value expected in the stratosphere from cosmic-ray data and the Thomson theory.

551.5

10402 AIRBORNE MEASUREMENT OF ATMOSPHERIC CONDUCTIVITY IN FIFTEEN-DAY-OLD THERMONUCLEAR DEBRIS. R.V.Anderson and G.P.Serbu.
J. geophys. Res., Vol. 65, No. 1, 223-6 (Jan., 1960).

Total atmospheric conductivity was measured on a flight through fifteen-day-old thermonuclear debris. Significant increases in conductivity were noted within the debris at altitudes of 17 000 and 5000 ft. The relative increases at the two altitudes are found to be in good agreement with values calculated from ion-equilibrium conditions.

551.5

10403 SOME PROBLEMS CONCERNING THE TERRESTRIAL ATMOSPHERE ABOVE ABOUT THE 100 km LEVEL. D.R.Bates.
Proc. Roy. Soc. A, Vol. 253, 451-62 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8522 of 1960). Consideration is given to the significance of recent rocket and satellite studies relating to the structure of the thermosphere. It is shown that unless hydrogen atoms are being captured very rapidly from interplanetary space they must be very rare indeed at the base of the exosphere. Stress is laid on the importance of the steepness of the temperature gradient above the E layer in connection with the thermal economy. Though no final conclusion is reached, it is thought that the view that the ionizing radiation from the sun is the main sources of heat is more attractive than any alternative view yet put forward. An analytic model of the thermosphere is described in the appendix.

551.5 : 523.2

INTERPLANETARY SPACE AND THE EARTH'S OUTERMOST ATMOSPHERE. See Abstr. 8484

551.5

10404 TURBULENCE AT METEOR HEIGHTS. C.O.Hines.
J. geophys. Res., Vol. 64, No. 8, 939-40 (Aug., 1959).

A preliminary outline of a new approach to the study of motions at meteor heights is given, the fundamental assumption being that these motions are perturbation velocities associated with propagating atmospheric waves. Several observed features of the large-scale motions are thereby explained, and a basis is laid for the study of associated smaller-scale "turbulent" motions. It is found that smaller-scale motions having appreciable amplitude need not be anticipated a priori, contrary to an earlier conclusion derived from conventional turbulence theory.

551.5

10405 MOTIONS IN THE MAGNETOSPHERE OF THE EARTH. T.Gold.
J. geophys. Res., Vol. 64, No. 9, 1219-24 (Sept., 1959).

The conditions determining the dynamical behaviour of the ionized gas in the outer atmosphere of the earth are discussed. It is proposed to call this region in which the magnetic field of the earth dominates the "magnetosphere". Observations by Van Allen and others [Nature (London), Vol. 183, 430 (1959)] indicate that this zone reaches out to between 5 and 10 earth radii, depending on the degree of magnetic disturbance. It is shown that the existence of an insulating layer at the base of this region, namely the non-ionized atmosphere, completely changes the type of control exerted by the magnetic field, allowing a class of motions to occur freely without the need to overcome any magnetic forces. The extent to which such motions may occur is discussed, and some of the indications from airglow and magnetic observations are mentioned. The theory predicts that, at the level of the F2 layer and above, most motions will show strict symmetry between the two base points of a magnetic line of force.

551.5

10406 A VERTICAL CROSS SECTION THROUGH THE "POLAR-NIGHT" JET STREAM. T.N.Krishnamurti.
J. geophys. Res., Vol. 64, No. 11, 1835-44 (Nov., 1959).

Because of the great altitude of the core of the "polar-night" jet stream, only isolated rawinsonde observations have penetrated the core, and this scarcity of data renders the construction of synoptic cross-sections difficult. For a more definitive determination of the structure of this current, all soundings of the North American Artic were combined into one cross-section for a four-day period when the jet stream was in relatively steady state. It turned out that the core was located at a height of 26 km and had a speed of 135 knots. Below this altitude the atmosphere was isothermal in the mean; above it, temperatures increased upward. Cross-sections were constructed for the wind components parallel and normal to the jet axis, temperature, potential temperature, and absolute and potential vorticity. Comparison was also made between observed and geostrophic wind speeds; a high correlation was found to exist.

551.5

10407 DETERMINATION OF UPPER-ATMOSPHERE AIR DENSITY AND SCALE HEIGHT FROM SATELLITE OBSERVATIONS. G.V.Groves.
Proc. Roy. Soc. A, Vol. 252, 16-27 (July 7, 1959).

A solution is obtained for the rate of semi-major axis and perigee distance of a satellite orbit with time due to the resistance of the atmosphere. The logarithm of air density is assumed to vary quadratically, with height, and the oblateness of the atmosphere is taken into account. The calculations of perigee air density in terms of the rate of change of satellite period is dealt with; and the method is applied to data at present available on six different satellites. The variation of air density with height is obtained as

$$\ln \rho = -28.59(\pm 0.15) - (h-200)/46\,(\pm 5) + 0.028(\pm 0.013)\,(h-200)^2/(46)^2$$

for h in the range of approximately 170 to 700 km, where ρ is in g/cm³, h is in km and standard deviations are given in brackets.

551.5

10408 DETERMINATION OF UPPER-ATMOSPHERE AIR-DENSITY PROFILE FROM SATELLITE OBSERVATIONS. G.V.Groves.
Proc. Roy. Soc. A, Vol. 252, 28-34 (July 7, 1959).

The theory previously developed (preceding abstr.) for the changes

in the perigee distance and semi-major axis of a satellite orbit due to air drag is extended to enable the air-density profile (i.e. its relative variation with height) to be derived from the motion of the orbit's perigee. The solution is first obtained in terms of the change in perigee distance and then in terms of the change in the radius of the earth at the sub-perigee point. Data are analyzed by the two methods, leading to 39(±9) and 36(±15) km for the scale height in the 180 and 220 km altitude regions.

551.5

10409 ANALYTIC AND EXPERIMENTAL ELECTRICAL CONDUCTIVITY BETWEEN THE STRATOSPHERE AND THE IONOSPHERE. R.E.Bourdeau, E.C.Whipple, Jr and J.F.Clark.
J. geophys. Res., Vol. 64, No. 10, 1363-70 (Oct., 1959).

Data on atmosphere conductivity obtained experimentally in the altitude region between 35 and 80 km by use of rocket-borne Gerdien condensers are presented. Analytic expressions based on ion equilibrium and ionization by cosmic rays only are derived for comparison. The experimental technique is described, and several factors that might influence the measurements are evaluated. There is good agreement between the measured and predicted values of negative conductivity at altitudes up to 50 km. Low conductivity values observed between 50 and 80 km are attributed to ionic diffusion to particulate matter, the reduction agreeing quantitatively with that calculated from present estimates of the radius and concentration of noctilucent cloud particles. It is suggested that meteoritic dust may be an important agent for electron destruction in the ionosphere.

551.5

10410 ON THE ROTATION OF THE POLAR IONOSPHERIC REGIONS. C.O.Hines.
J. geophys. Res., Vol. 65, No. 1, 141-44 (Jan., 1960).

The possibility of magnetic coupling between the polar regions of the earth's ionosphere and the interplanetary gas has led to the suggestion that the polar ionosphere may not rotate with the earth. The depth to which the effects of the interplanetary drag might penetrate is examined here with the aid of two simple models. The results are not conclusive, but they do indicate that heights as low as the E region may be involved.

551.5

10411 ON ARTIFICIAL GEOMAGNETIC AND IONOSPHERIC STORMS ASSOCIATED WITH HIGH-ALTITUDE EXPLOSIONS. S.Matsushita.
J. geophys. Res., Vol. 64, No. 9, 1149-61 (Sept., 1959).

Geophysical effects of nuclear explosions at Johnston Island on August 1 and 12, 1958, were studied by means of I.G.Y. geomagnetic and ionospheric data collected in the Pacific area and the American continent. The explosion heights are estimated at 70 to 80 km and about 40 km, respectively. Immediately after each explosion, three phenomena occurred. (1) Strong counterclockwise circular electric currents were formed in the vicinity of Johnston Island at 80 to 100 km height. They caused the immediate occurrence of artificial magnetic storms in the central Pacific. (2) High-energy particles moving along the magnetic lines of force caused auroras seen from Apia, and also caused the main parts of the magnetic storms observed at Apia. (3) X-rays due to the explosion caused the increase of the D-region absorption observed at Maui. Irregularities of the electron density in the F-layer at Maui and the maximum geomagnetic change at Honolulu were caused by a shock wave from the explosion. The degree of ionization in a wide area in the central Pacific increased to about 10 times normal within 35 min after the first explosion and within about 6 hr after the second. Then a strong radio absorption continued for many hours.

551.5

10412 A THEORY OF ELECTROSTATIC FIELDS IN A HORIZONTALLY STRATIFIED IONOSPHERE SUBJECT TO A VERTICAL MAGNETIC FIELD. D.T.Farley, Jr.
J. geophys. Res., Vol. 64, No. 9, 1225-33 (Sept., 1959).

A theory is developed to described quantitatively the idea that in an ionized gas subject to an imposed magnetic field, such as the ionosphere, the lines of magnetic flux are approximately equipotential lines. The ionosphere is assumed to be horizontally stratified, and the case in which the earth's magnetic field is vertical is considered. Small-scale electrostatic fields are studied with a view towards elucidating the phenomena of spread F and radio star scintillation. The analysis indicates that in the ionosphere the results are strongly affected by the variation of conductivity with height, as well as by the anisotropy. For a reasonable model of the ionosphere it is shown that it is possible, under certain conditions, for a horizontal field three kilometres or larger in extent, at a height of about 120 or more kilometres, to produce a similar, localized electric field in the F region, not appreciably reduced in strength. The height of the source is the most important factor, but the temperature and ionization-density profiles are also significant. The fact that the strength of the small-scale fields in the F region could vary by one or two powers of 10 for plausible diurnal variations of the ionospheric parameters suggests that these fields could perhaps be responsible for the puzzling diurnal behaviour of spread F and radio star scintillation.

551.5

10413 EVIDENCE FOR A 200-MEGACYCLES PER SECOND IONOSPHERIC FORWARD SCATTER MODE ASSOCIATED WITH THE EARTH'S MAGNETIC FIELD.
J.L.Heritage, S.Weisbrod and W.J.Fay.
J. geophys. Res., Vol. 64, No. 9, 1235-41 (Sept., 1959).

In July, 1958, two experiments were carried out to study the gross features of an ionospheric scatter mode observed at 200 Mc/s in the southwestern United States. The transmitter was pulsed and high powered; transmission took place during alternate 1 min periods on one of two pencil beams, differing in azimuth by 5°. The direction of transmission was southeast to northwest; and the hot spots, or areas of strong illumination in the E-layer, were about 850 km from the transmitter. Contours representing specular reflection from earth magnetic field lines passing through the hot spots were calculated. In the first experiment one mobile receiver was positioned on the specular contour for each beam. Both receivers were well south of the great-circle paths. As the beams were switched, the level of the scatter signal changes in antiphase at the two receivers, suggesting that the scattered energy is fairly sharply peaked about the specular contour. The scatter signal was characterized by rapid fading and broad angle of arrival in azimuth. The second experiment used one receiver on the great-circle path and the other on one of the specular magnetic field contours. No scatter-type signals were observed on the great circle; the station located on the magnetic contour showed the usual rapid-fading scatter signals.

551.5

10414 OBSERVATIONS OF THE IONOSPHERE OVER THE SOUTH GEOGRAPHIC POLE. R.W.Knecht.
J. geophys. Res., Vol. 64, No. 9, 1243-50 (Sept., 1959).

Monthly median values of penetration frequencies of the ionosphere over the south geographic pole have been examined. Twenty months of data (June 1957 to January 1959) are included in the study of f_0F2, while f_0E and f_0F1 median values are shown for 6 summer months (November and December, 1957; January, November, and December 1958; January 1959). It is found that F-region ionization persists throughout the 6 month winter night. Marked diurnal variations are observed in the monthly medians of f_0F2 even though the usual daily variation in solar elevation is absent at this unique location. A small but significant diurnal variation is also found in f_0F1. In contrast, f_0E exhibits no regular daily fluctuation, but seems to depend to a greater extent on the level of solar activity.

551.5

10415 MEASUREMENTS OF IONOSPHERIC ELECTRON CONTENT BY THE LUNAR RADIO TECHNIQUE.
S.J.Bauer and F.B.Daniels.
J. geophys. Res., Vol. 64, No. 10, 1371-6 (Oct., 1959).

Measurements of the Faraday rotation of lunar radio echoes on a frequency of 151 Mc/s are used to determine the time variation in the total ionospheric electron content. Absolute values of ionospheric electron content are determined from these measurements in conjunction with information on the electron content below the F2 peak computed from vertical-incidence sounding data. Diurnal day-to-day, and seasonal variations in the total electron content are presented. The ratio $n_a:n_b$ of the number of electrons above the F2 peak to that below is found to be in the order of 4 to 5 during three summer nights (June) before sunrise and about equal to 3 after sunrise. For two days in November the ratio $n_a:n_b$ is found to be equal to about three both before and after sunrise. Possibilities of inferring other characteristics of the upper ionosphere from observed variations in the total electron content are briefly discussed.

551.5

10416 DETECTION OF AN ELECTRICAL CURRENT IN THE IONOSPHERE ABOVE GREENLAND. L.J.Cahill, Jr.
J. geophys. Res., Vol. 64, No. 10, 1377-80 (Oct., 1959).

During a magnetic storm on 6 August 1957, a rocket-borne magnetometer was launched near the coast of Greenland. The time and location of the flight and the magnetic measurements obtained provide evidence that the rocket entered the postulated sheet current flowing across the polar cap. An estimate is made of the magnitude of the detected current.

551.5

10417 INTERNATIONAL SYMPOSIUM ON FLUID MECHANICS IN THE IONOSPHERE.
J. geophys. Res., Vol. 64, No. 12, 2037-2238 (Dec., 1959).

The symposium was held at Cornell University in July 1959. A brief review (5 pages) by Bolgiano, the organizing secretary, is followed by a detailed account of the transactions (50 pages) and then by copies of 28 individual papers. Abstracts of these papers will be found in this or succeeding issues of Physics Abstracts.

551.5

10418 THE MESOPAUSE REGION OF THE IONOSPHERE. J.D.Whitehead.
Nature (London), Vol. 186, 461 (May 7, 1960).

It is argued that the suggestion of Gregory, that the electrons in the 80 to 90 km region are caused by the photoionization of dust in the mesopause, is untenable. The ionizing radiation is not sufficiently intense to give the required electron density. Too large a dust density will result in the absorption of all the electrons during the night-time. R.D.Davies

551.5 : 538.3

IONOSPHERIC HEATING BY HYDROMAGNETIC WAVES.
See Abstr. 9181

551.5

10419 A RELATION BETWEEN GIANT TRAVELLING DISTURBANCES AND SPORADIC E IONIZATION. L.H.Heisler.
Nature(London), Vol. 184, 1788-9 (Dec. 5, 1959).

Examination of ionograms taken at widely spaced stations in Australia shows many cases when the appearance of E_s traces occur simultaneously with the onset of large travelling disturbances. A new theory of the formation of E_s is being developed, based on the concept of downard transport of ionization during the first phase of an F-region disturbance. G.M.Brown

551.5

10420 HORIZONTAL DRIFTS IN THE E-REGION AT WALTAIR. R.Raghava Rao and B.Ramachandra Rao.
Nature (London), Vol. 185, 27-8 (Jan. 2, 1960).

A summary of results obtained by the fading technique on an frequency of 2.5 Mc/s at Waltair (N 17° 43') covering the period June 1957 - May 1959. Some differences with the results obtained at higher latitude stations are noted, including the predominance of the 24-hour component, rather than the 12-hour component, at Waltair. G.M.Brown

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10421 NOTE ON THE CAUSE OF IONIZATION IN THE F-REGION. M.H.Rees and W.A.Rense.
J. geophys. Res., Vol. 64, No. 9, 1251-5 (Sept., 1959).

Recent rocket data on the intensity of the solar 303.8A He II line at the 140 km and 212 km level of the upper atmosphere are utilized to investigate the possibility that this radiation may be largely responsible for the heating and ionization effects in the F-region. Electron densities at 140 km and at 212 km are computed on the basis that the 303.8A photons ionize oxygen atoms. The computed results compare favourably with observed values of electron densities measured at these heights on ionograms taken at the same time as the rocket flight which yielded the 303.8A intensity data.

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10422 THE HEIGHT OF F-LAYER IRREGULARITIES IN THE ARCTIC IONOSPHERE. H.F.Bates.
J. geophys. Res., Vol. 64, No. 9, 1257-65 (Sept., 1959).

Results and interpretations of oblique-incidence soundings of the arctic ionosphere are presented. Anomalous echoes are found to be prevalent in high latitudes in contrast to lower latitudes where 2F ground scatter predominates. One of the echoes seen regularly at College, Alaska, has been identified as direct F-layer (1F) back scatter propagated via the least-time mode. The observations of the 1F echo provide direct evidence of the presence of irregularities in the F layer between heights of 350 and 500 km. The 1F echoes are recorded regularly at night and occasionally during the day in disturbed periods. They appear to be associated with auroral ionization. The analys of ground-scattered (2F) echoes is extended from a plane to a spherical geometry, and it is shown that a geometrical extension of the plane-earth theory is adequate. The observed range-frequency dependence differs only slightly from that predicted by the latter theory.

551.5 : 550.3

IONOSPHERIC F-LAYER DISTURBANCES: CORRELATION WITH MICROPULSATIONS OF THE EARTH'S MAGNETIC FIELD.
See Abstr. 10395

551.5

10423 THE GEOMAGNETICALLY-TRAPPED CORPUSCULAR RADIATION. J.A.Van Allen.
J. geophys. Res., Vol. 64, No. 11, 1683-9 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). The available data of the charged particles (electrons and protons) trapped temporarily in the earth's geomagnetic field is reviewed. The nature of the trapped radiation is discussed, and it is suggested that it consists of charged particles trapped in the earth's magnetic field in the manner suggested in the classical theories of Poincaré, Störmer and Alfvén. Tentative theories of the origin of the radiation are given and its geophysical role is discussed. Preliminary results of the intensities of the radiation are quoted and the possibility of corpuscular radiation being trapped around the moon and around other planets is suggested. C.F.Barnaby

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10424 GEOMAGNETICALLY-TRAPPED CORPUSCULAR RADIATION. J.A.Van Allen.
Proc. Roy. Soc. A, Vol. 253, 525-9 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). A comprehensive bibliography of 58 references up to May, 1959.

551.5

10425 EFFECT OF MAGNETIC ANOMALY ON PARTICLE RADIATION TRAPPED IN GEOMAGNETIC FIELD. A.J.Dessler.
J. geophys. Res., Vol. 64, No. 7, 713-15 (July, 1959).

Anomalies in the geomagnetic field will affect the mirror altitude of trapped particles. A negative magnetic anomaly (abnormally weak magnetic field strength) will lower the mirror altitude of the trapped particles which are reflected near the anomaly. The large negative anomaly near Capetown, South Africa, will lower the local mirror altitude by about 1000 km. Since the trapped particles drift around the earth's magnetic axis, the outward projecting "horns" in the contours of constant radiation intensity as revealed by Satellite 1958 ε may be explained on the basis of this anomaly and the east-west drift of the trapped particles. The gap in the radiation belt as revealed by Lunar Probe Pioneer III is also apparently related to this anomaly, and the intensity at the minimum relative to the adjoining maxima indicates that most of the trapped particles are reflected at relatively low altitudes.

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10426 ON THE POSSIBILITY OF DETECTING SYNCHROTRON RADIATION FROM ELECTRONS IN THE VAN ALLEN BELTS. R.B.Dyce and M.P.Nakada.
J. geophys. Res., Vol. 64, No. 9, 1163-8 (Sept., 1959).

It is known that a moving charged particle can be trapped in the earth's magnetic field indefinitely. Indeed, high-speed charged particles, presumably electrons, have recently been observed in nature by United States satellites and lunar probes. These electrons are relativistic and should emit radiofrequency wide-band noise similar to that observed in synchrotrons even as high as optical frequencies. Most of this energy is unable to reach the earth's surface because of reflection from the intervening ionosphere. A small fraction of this energy, however, exists at v.h.f. capable of

passing down through the ionosphere. It would be desirable to conduct an experimental search for this radiation in order to learn more about the electron energies that exist and to allow observation of the Van Allen belt as a function of time.

551.5

10427 THE ARGUS EXPERIMENT. N.C.Christofilos.
J. geophys. Res., Vol. 64, No. 8, 869-75 (Aug., 1959).

A geophysical experiment on global scale was conducted during August and September, 1958. Three small A-bombs were detonated beyond the atmosphere at a location in the south Atlantic. The purpose of the experiment was to study the trapping of the relativistic electrons (produced by the β-decay fission fragments) in the geomagnetic field. The released electrons are trapped by this field oscillating along the magnetic lines between two mirror points. In addition to this motion the electrons drift eastward, creating a thin electron shell around the earth. The lifetime and location of the thus-created global electron shell were measured by satellite- and rocket-borne instruments. Auroral luminescence was observed at the conjugate points. The electron shell exhibited remarkable stability during its lifetime. No motion of the shell or change in its thickness was detected. The usefulness of such electron shells for interpreting geophysical phenomena and possible future experiments is discussed.

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10428 SATELLITE OBSERVATIONS OF ELECTRONS ARTIFICIALLY INJECTED INTO THE GEOMAGNETIC FIELD. J.A.Van Allen, C.E.McIlwain and G.H.Ludwig.
J. geophys. Res., Vol. 64, No. 8, 877-91 (Aug., 1959).

Four radiation detectors in satellite 1958ϵ (Explorer IV) easily and promptly observed the geomagnetically trapped electrons resulting from the three high-altitude nuclear detonations Argus I, II and III in August-September, 1958 (see preceding abstract). An account of over 160 satellite passes through the three Argus "shells" of artificially injected electrons is given, and a preliminary appraisal of the geophysical significance of these experiments is offered.

551.5

10429 PROJECT JASON MEASUREMENT OF TRAPPED ELECTRONS FROM A NUCLEAR DEVICE BY SOUNDING ROCKETS. L.Allen, Jr, J.L.Beavers, II, W.A.Whitaker, J.A.Welch, Jr and R.B.Walton.
J. geophys. Res., Vol. 64, No. 8, 893-907 (Aug., 1959).

Solid-propellant rockets were sent to altitudes of 800 km from three stations in the eastern United States to observe electrons injected into the geomagnetic field from a small high-altitude nuclear detonation. The electron flux was measured by an assembly of Geiger counters. Shortly after a nuclear detonation above the south Atlantic, a narrow region of high counting rate was observed. The geometry of the observations is related to the geomagnetic field. The region consisted of an intense band about 20 km wide (half-width at half maximum counting rate) and less intense wings extending at least 700 km north and perhaps 700 km south of the band. Neither position nor width of the band changed during the observations, which consisted of periodic soundings until 100 hr after the nuclear detonation. The intensity of both the wings and the band decayed during the measurements as 1/t, which is consistent with the hypothesis that small-angle scattering is the dominant loss mechanism. The angular distribution of the radiation was measured, and the electron flux was observed to be confined very nearly to a plane perpendicular to the field lines. Spectral measurements show far fewer electrons above 4 MeV than were expected from the fission beta spectrum. Betas trapped from the decay of neutrons emitted from large-yield high-altitude weapon tests in the Pacific were also noted.

551.5

10430 THEORY OF GEOMAGNETICALLY TRAPPED ELECTRONS FROM AN ARTIFICIAL SOURCE. J.A.Welch, Jr and W.A.Whitaker.
J. geophys. Res., Vol. 64, No. 8, 909-22 (Aug., 1959).

A theoretical formulation has been made for the history of an artificial shell of geomagnetically trapped electrons resulting from low-yielding nuclear detonations in the exosphere. The formulation assumes a source distribution and gives the spatial distribution of trapped electrons along the magnetic field lines, the drift rate around the world, and the configuration of the resulting shell. Interactions of the shell with the atmosphere lead to an electron density decaying inversely with time from injection for times longer than a characteristic lifetime that is a function of altitude and electron energy. The electron flux is found to be very nearly confined to a plane perpendicular to the field direction after several characteristic lifetimes. Scattering by geomagnetic fluctuations is probably not an important loss mechanism for the artificial shell, but it may be important for the hard component of the natural trapped belt. The effect of the geomagnetic anomaly over the south Atlantic has been described qualitatively. Jason rocket data and Explorer IV satellite data have been compared with the theoretical results.

551.5

10431 OPTICAL, ELECTROMAGNETIC, AND SATELLITE OBSERVATIONS OF HIGH-ALTITUDE NUCLEAR DETONATIONS. I. P.Newman.
J. geophys. Res., Vol. 64, No. 8, 923-32 (Aug., 1959).

After each of the high-altitude detonations in the Argus experiment, visual auroras were observed in the detonation area. After the third event an aurora was observed in the conjugate area. After the second and third events, signals attributed to hydromagnetic waves were detected in the conjugate region; these signals had a periodicity of about 1 c/s. The maximum change in the magnetic field was about 1 gamma. If propagated along the magnetic line of force the velocity was about 2000 km/sec. Sporadic E was observed after the third event in the conjugate area. Comparative records of the 5577 A and 3914 A lines were obtained in the detonation area.

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10432 OPTICAL, ELECTROMAGNETIC, AND SATELLITE OBSERVATIONS OF HIGH-ALTITUDE NUCLEAR DETONATIONS. II. A.M.Peterson.
J. geophys. Res., Vol. 64, No. 8, 933-8 (Aug., 1959).

The radio effects of the Argus detonations were measured using (1) 30 Mc/s radars designed to obtain echoes from the aurora or from the earth's surface mirrored in an enhanced ionospheric layer; (2) v.l.f. receivers for monitoring distant transmitters or atmospheric noise sources in search of changes in signal strength; (3) riometers for recording cosmic noise absorption or v.h.f. shot-created noise at 30, 60, and 120 Mc/s. Results included (1) auroral echoes in the vicinity of the launch point after all three shots and near the conjugate points after the first and third shot; (2) sudden depressions of 6 to 12 dB of the signal from England (19.6 kc/s) at Madrid and the Azores; (3) no ionospheric absorption at the conjugate location.

551.5

10433 THE SOUTHERN AURORAL ZONE IN GEOMAGNETIC LONGITUDE SECTOR 20°E. S.Evans and G.M.Thomas.
J. geophys. Res., Vol. 64, No. 10, 1381-8 (Oct., 1959).

Visual auroral observations from the Halley Bay, Shackleton, and Southice antarctic bases, are tabulated to show how the frequency of occurrence of aurora varied with the geomagnetic latitude, from 63° to 79°, in the sector 20°E during the I.G.Y. The distribution of quiet arcs, and its diurnal variation, are given particular attention. The centre of the quiet arc zone is found to be at geomagnetic latitude 71.7°; the interquartile range is 2°.

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10434 ANTARCTIC AURORAL OBSERVATIONS, ELLSWORTH STATION, 1957. J.M.Malville.
J. geophys. Res., Vol. 64, No. 10, 1389-93 (Oct., 1959).

Auroral observations made during the Antarctic winter of 1957 are summarized. The data discussed include daily variation, east–west drift, and hydrogen emission. From a comparison of observations made at Ellsworth and the South Pole, evidence is obtained of a spiralling zone of maximum auroral activity.

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10435 NOTE ON CONJUGATE POINTS OF GEOMAGNETIC FIELD LINES FOR SOME SELECTED AURORAL AND WHISTLER STATIONS OF THE I.G.Y. E.H.Vestine.
J. geophys. Res., Vol. 64, No. 10, 1411-14 (Oct., 1959).

A method for computing field lines in space is used to derive conjugate points of some auroral and magnetic stations of the I.G.Y. The study uses a total of 48 coefficients with computations done on an electronic computer.

551.5

10436 THE NIGHTLY VARIATION OF AURORAS AT A SUB-AURORAL STATION. J.W.Chamberlain and H.M.Thorson.
J. geophys. Res., Vol. 65, No. 1, 133-6 (Jan., 1960).

The observing records of Barnard and more recent patrol photographs of the sky have been studied for an indication of a nightly variation in the occurrence of auroras at Yerkes Observatory. There appears to be a maximum probability in the neighbourhood of local magnetic midnight, as at stations closer to the auroral zone. Some implications to auroral theory are discussed.

551.5

10437 CORRELATION OF AUDIO-FREQUENCY ELECTROMAGNETIC RADIATION WITH AURORAL ZONE MICROPULSATIONS. J.Aarons, G.Gustafsson and A.Egeland.
Nature (London), Vol. 185, 148-51 (Jan. 16, 1960).

The occurrence of auroral zone micropulsations of the earth's magnetic field, observed at Kiruna, have been found to correlate well with e.m. radiation in the audio frequency band (10 c/s-10 kc/s). There are two distinct low frequency bands, the lower ("noise" centred on 750 c/s) showing a smaller band-width than the upper ("hiss" with maximum intensity in the range 2.3-3.4 kc/s). It is suggested that the lower band may arise from radiation by protons, although it may be another component of the "hiss". G.M.Brown

551.5 : 535.8

RECORDING OF AURORAL SPECTRA USING A PHOTOELECTRIC SPECTROMETER. See Abstr. 8791.

551.5 : 621.396.96

10438 CORRELATION STUDIES OF RADIO-AURORA, MAGNETIC, AND EARTH-CURRENT DISTURBANCES. B.K.Bhattacharyya.
Canad. J. Phys., Vol. 38, No. 5, 624-37 (May, 1960).

Correlation studies of the radar echo occurrence rate from aurora in half-hourly intervals at Ottawa, S and S_d components of the horizontal magnetic field H at Agincourt, and the disturbance diurnal variation of earth current at Crow River have been carried out. Short-time variations in auroral echo strength and moderate perturbations in H have also been correlated. The auroral echo occurrence rate seem to have a diurnal variation characteristic similar to that of H. It is found that auroral activity always precedes magnetic activity. The variation of the delay time between the two phenomena shows a local time-dependence, being practically constant and quite small (0-15 minutes) before local midnight and increasing afterwards. This variation of the delay time appears to have a connection with reports of others regarding reversal of the direction of auroral ionization drift from west to east somewhere around midnight with subsequent magnetic perturbations which change from positive to negative. No definite conclusion could be reached regarding the relationship of earth current to other factors because of a practically random variation of cross-correlation coefficients from month to month.

551.5

10439 ON THE GEOMETRY OF RADIO REFLECTIONS FROM AURORA. P.A.Forsyth.
Canad. J. Phys., Vol. 38, No. 5, 593-603 (May, 1960).

By assuming that auroral radio reflections are produced by volume scattering in clouds of ionization having the same spatial configuration as the visible auroral structures, and by taking into account the radar pulse duration and antenna beam width, it is possible to predict the probability of echo occurrence as a function of range and azimuth. This echo distribution is quite similar to that observed experimentally even when "aspect sensitivity" of the individual scatterer is neglected. Unfortunately, the optical evidence is not sufficiently extensive to permit precise calculations to be made, nor the radio evidence to permit detailed comparisons, but previous estimates of the shape of the scattering structures that have been based on the azimuthal echo distribution without regard to the factors discussed here are likely to be seriously in error.

551.5

10440 VHF AND UHF RADAR OBSERVATIONS OF THE AURORA AT COLLEGE, ALASKA. R.I.Presnell, R.L.Leadabrand, A.M.Peterson, R.B.Dyce, J.C.Schlobohm and M.R.Berg.
J. geophys. Res., Vol. 64, No. 9, 1179-90 (Sept., 1959).

During routine u.h.f. auroral radar investigations an unusual daytime auroral effect has been discovered. It apparently occurs most frequently when: (1) the reflecting region is sunlit; (2) the atmosphere is undergoing its greatest change (early morning and late afternoon). There is a minimum of echo occurrence at noon when atmospheric conditions are stable. Daytime aurora is distributed over a larger region of space than the more commonly observed night-time aurora. The night-time and daytime echoes are labelled discrete and diffuse, respectively. They can be differentiated in several ways. Discrete echoes are identified by their relatively short duration, their occurrence only at night, and their orientation in the E-layer along a plane at right angles to radar beam; hence, the echo does not shift in range with change in elevation angle of the radar antenna. Diffuse echoes last longer, occur only during the day, and are apparently oriented in the E-layer along a plane almost parallel to the surface of the earth; hence, the echo does shift in range when the radar-antenna elevation angle is changed. The primary effects of increasing the observation frequency are decreasing echo amplitudes and decreasing maximum off-perpendicular angle. The observed aspect sensitivity and the wavelength dependence are interpreted in terms of the scattering approach of Booker (Abstr. 8531 of 1956). Using the experimental u.h.f. results, a model of the underdense ionosphere has been developed consisting of irregularities which have dimensions of 0.1 meter across and 3.5 meters along the magnetic field lines. The echo results are compared with auroral zone effects, and described together with measurements of the frequency spectra (Doppler shift and spread) of an aurorally reflected continuous-wave signal.

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10441 HIGH-ALTITUDE 106.1-Mc RADIO ECHOES FROM AURORAL IONIZATION DETECTED AT A GEOMAGNETIC LATITUDE OF 43°. J.C.Schlobohm, R.L.Leadabrand, R.B.Dyce, L.T.Dolphin and M.R.Berg.
J. geophys. Res., Vol. 64, No. 9, 1191-6 (Sept., 1959).

Auroral echoes have been detected using a radar at 106.1 Mc/s located at 43° geomagnetic latitude. The geometry of reflection for ionization aligned with the earth's magnetic field lines is such that, for a geomagnetic latitude of 43°, reflection can occur as high as 300 km. The results of these observations are presented, with an interpretation of the height of reflections and a discussion of the advisability of making low-latitude auroral echo investigations.

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10442 DOPPLER INVESTIGATIONS OF THE RADAR AURORA AT 400 Mc.
R.L.Leadabrand, R.I.Presnell, M.R.Berg and R.B.Dyce.
J. geophys. Res., Vol. 64, No. 9, 1197-1203 (Sept., 1959).

By means of a relatively sensitive 400 Mc/s radar located at College, Alaska, the variation of Doppler shift of auroral echoes was determined as a function of the following parameters: (1) azimuth angle of the radar ray; (2) off-perpendicular intersection angle of the radar ray and the earth's magnetic field; (3) elevation angle of the radar ray; (4) range of the echoes; (5) altitude of the reflection centres; (6) time of day; (7) number of occurrences; (8) strength of the echoes. These data have been further delineated in terms of the type of echo seen (discrete or diffuse) and whether the data were taken before or after magnetic midnight. An estimate of the spectrum spread of auroral echoes was also determined by pulse and by c.w. techniques. A consistent trend in these data has been found which would indicate an east–west motion of the ionospheric irregularities. There is no appreciable variation in the direction of motion with time of day or with respect to magnetic midnight. The mean velocity of the east–west motion appears to be 500 m per second. These conclusions agree with those of Kim and Currie (1958) but disagree with those of Lyon and Kavadas (1958), Nichols (1957), and Bullough et al. (1957).

551.5

10443 AURORA-LIKE RADAR ECHOES OBSERVED FROM 17° LATITUDE.
R.B.Dyce, L.T.Dolphin, R.L.Leadabrand and R.A.Long.
J. geophys. Res., Vol. 64, No. 11, 1815-18 (Nov., 1959).

Anamalous echoes are regularly observed by a shipborne radar located at Antigua, British West Indies. These echoes, observed at 32 and 140 Mc/s, have many of the characteristics of echoes from the auroras observed in the arctic, although visible auroras should not be observable at Antigua more frequently than once in 7 years. Similar observations at Stanford University indicate a correlation with one kind of sporadic-E ionization.

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10444 **A DAYTIME MAXIMUM OF OBLIQUE AURORAL REFLEXIONS OBSERVED IN THE AURORAL ZONE.**
A.Egeland, B.Hultqvist and J.Ortner.
Nature (London), Vol. 185, 519 (Feb. 20, 1960).

The statistics of radio-wave reflection from the aurora between March and June 1959 shows a daytime maximum between 1200 and 1600 hr in addition to the usual night time maximum at about 0300 hr. The signal of 92.6 Mc/s was transmitted from 65.8°N, 24.8°E and received at 67.8°N, 20.4°E. R.W.Nicholls

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10445 **INTERFEROMETRIC MEASUREMENTS UPON THE GREEN LINE OF THE NIGHT AIRGLOW.** M.Perrin.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2406-8 (March 28, 1960). In French.

The construction of a photoelectric Fabry-Perot interferometer designed to study the 5577A line of the night airglow is described. Measurements made with this instrument in the Sahara lead to a temperature of the emitting layer between 175° and 235°K. R.W.Nicholls

551.5

10446 **TELLURIC ORIGIN OF THE WHISTLER MEDIUM.** F.S.Johnson.
Nature (London), Vol. 184, 1787-8 (Dec. 5, 1959).

Considerations are advanced which show that the ionized medium responsible for whistler propagation cannot be of solar or interplanetary origin. The rate of loss into the ionosphere of trapped solar protons is such that they would all be lost in less than a day, while a correspondingly high injection rate to compensate cannot be accepted. It is therefore proposed that the whistler medium is of telluric origin, resulting from the nearly resonant charge-exchange reaction $O^+ + H \rightarrow O + H^+$ occurring at the base of the exosphere (550 km). G.M.Brown

551.5

10447 **EFFECT OF LATITUDE ON THE DIURNAL MAXIMUM OF "DAWN CHORUS".** J.H.Pope.
Nature (London), Vol. 185, 87-8 (Jan. 9, 1960).

A more detailed examination of the relation between the time of occurrence of the diurnal maximum of chorus and geomagnetic latitude is given, made possible by the increased data available for the I.G.Y. A residual east–west asymmetry is found (also present when magnetic rather than geomagnetic latitude is considered) which cannot be explained in terms of a westward shift of the geomagnetic equator resulting from rotation. It is shown that the use of approximate geomagnetic latitudes based on an eccentric dipole field removes the effect. G.M.Brown

551.5

10448 **RARE HISS, EARTH CURRENTS AND MICROPULSATIONS ON NOVEMBER 27, 1959.**
E.M.Westcott, J.H.Pope, D.O.Dyer and W.H.Campbell.
Nature (London), Vol. 185, 231 (Jan. 23, 1960).

Report of an unusual series of events recorded at College, Alaska. The chorus-whistler equipment recorded a rising tone whistler, beginning at 2351 U.T. on Nov. 27, 1959, and becoming a hiss. Simultaneously, magnetic field micropulsations and an abrupt sudden-commencement earth current record were reported, while a red auroral arc was observed some 3 hours later. G.M.Brown

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10449 **ATMOSPHERIC RADIOACTIVITY LEVELS AT YOKOSUKA, JAPAN, 1954-1958.** L.B.Lockhart, Jr.
J. geophys. Res., Vol. 64, No. 10, 1445-9 (Oct., 1959).

Summarizes measurements made on the concentrations of some natural radioactive materials and of gross fission products in the air at ground level at Yokosuka, Japan, during the period 1954-1958. These data support the conclusions that the concentrations of both natural radioactive products and fission products in the air at ground level vary widely from time to time, that the change in the concentration of the natural radioactivity is related in a general way to the phenomena that control precipitation, and that the trend of the fission-product concentration has been upward during the past few years as a result of increasing nuclear testing.

551.5 : 525

10450 **THE FARADAY FADING OF RADIO WAVES FROM AN ARTIFICIAL SATELLITE.** F.H.Hibberd.
J. geophys. Res., Vol. 64, No. 8, 945-8 (Aug., 1959).

Faraday fading of signals from an artificial satellite is analysed in terms of the difference between the Doppler shifts of the ordinary and extraordinary components in the ionosphere. A procedure is outlined for determining the vertical distribution of electron density in the upper ionosphere. Explanations are given for the apparently excessive values of electron content yielded by measurements of Faraday fading and for the observation that the rate of Faraday fading is not exactly inversely proportional to the square of the wave frequency.

551.5 : 537.56

COMPLEX DOPPLER EFFECT THEORY. See Abstr. 9052

551.5 : 523.16

RADIO INTERFEROMETRY AT THREE KILOMETERS. See Abstr. 8482

551.5

10451 **ANALYSIS OF PHOTOELECTRONS FROM SOLAR EXTREME ULTRAVIOLET.**
H.E.Hinteregger, K.R.Damon and L.A.Hall.
J. geophys. Res., Vol. 64, No. 8, 961-9 (Aug., 1959).

The first rocket experiment for analysis of photoelectrons from a metal surface exposed to solar extreme ultraviolet around 115 miles altitude is evaluated. The soundness of the experimental techniques is confirmed, and the first data on photoelectron energy distribution are presented. Details on the simplified "photoelectric method" of radiation analysis are discussed, and the preliminary results of applying this method to the first flight data are given.

551.5

10452 **ATTENUATION OF INFRARED RADIATION BY FOGS.**
S.W.Kurnick, R.N.Zitter and D.B.Williams.
J. Opt. Soc. Amer., Vol. 50, No. 6, 578-83 (June, 1960).

Optical transmission was measured in fogs for wavelengths from 1-11 μ. The results, together with the data of Arnulf, Bricard, Curé and Véret, are analysed under the assumption that particle sizes in natural aerosols follow the distribution law proposed by Junge: $n(r) = Cr^{-p}$, where $n(r)dr$ is the number of particles per cm^3 with radii between r and r + dr, and C and p are some constants. The dependence of transmission on wavelength in fogs is of several forms, yet the theory accounts satisfactorily for each of them. Particle size measurements, when made, were in accord with the distribution law, and the values of p so obtained agree with the values inferred from optical transmission measurements.

551.5

10453 **SCATTERING FUNCTION FOR FOGS.** D.E.Spencer.
J. Opt. Soc. Amer., Vol. 50, No. 6, 584-5 (June, 1960).

The paper summarizes recent experimental data. It is shown that a wide range of conditions from very light to very dense fogs can be represented by a single shape of scattering function. The scattering function $F(\varrho)$ is defined graphically and by a table of values. Given this scattering function, the scattering coefficient of a fog can be defined in terms of the attenuation coefficient.

551.5 : 534.21

GRAVITATIONAL DAMPING OF SOUND. See Abstr. 8736

BIOPHYSICS · PHYSIOLOGICAL PHYSICS

574 : 621.389

10454 VOLTAGE CLAMP FOR BIOLOGICAL INVESTIGATIONS. J.R.Menninger, F.M.Snell and R.A.Spangler.
Rev. sci. Instrum., Vol. 31, No. 5, 519-21 (May, 1960).

A unique voltage clamp circuit for certain biological investigations, which features the provision of maintaining the clamped region at ground potential with the residual error balanced about ground, is discussed. Theoretical consideration of the circuit function indicates that the possibility of error arising from stray current pathways and loading of the electrodes is reduced by holding the clamped region close to ground. An additional secondary feed-back loop, in conjunction with this circuit, reduces switching transients and other high frequency noise and allows dynamic balance of the clamped region about ground potential despite asymmetries in the experimental circuit. This circuit has been employed, using commercially available operational amplifier units, to clamp the isolated frog skin for measurement of sodium transport flux. In this application, the assembly clamped the skin to well within 1 mV, with excellent d.c. stability and a theoretical error of 0.1% in response to 1 msec transients.

574

10455 RADIOACTIVE HAZARD RESULTING FROM THE EXPLOSIONS OF A "CLEAN" HYDROGEN BOMB AND OF A CONVENTIONAL FISSION BOMB. O.I.Leipunskii.
J. nuclear Energy, Vol. 9, No. 1-4, 28-40 (June, 1959). English translation of article in : Atomnaya Energiya, Vol. 3, 530 (1957).

An estimate is made of the danger to the world population arising from the creation of long-lived radioactive isotopes in nuclear explosions and from their dissemination over the globe. An ordinary fission bomb and a clean hydrogen bomb, taken to be a deuterium-tritium reaction, are considered. With a hydrogen bomb the principal agents are C^{14} and H^3, and with an ordinary bomb Sr^{90}, Cs^{137} and C^{14}. The doses delivered to the gonads and bones are calculated, and this leads to figures for the number of people born subsequently with hereditary defects and the number of cases of leukaemia (cancer of the blood). In this calculation the distribution of radioisotopes in animate and in inanimate matter is taken into account. The special aspects of a ground-level hydrogen explosion are considered. The total amount of energy liberated in radioactive decay by products of the explosion is three times greater in the case of deuterium-tritium bomb than for an ordinary bomb. However, taking an estimate over the whole period of decay of the reaction products, it is found that ten-megaton bombs of the two types give rise to roughly the same dose of radiation to the tissues, and claim approximately the same number of victims. The figures expected are :

	D–T bomb	Fission bomb
Dose to the tissues	0.05 r	0.04 r
Dose to the bones	0.05 r	0.088 r
Mutations (in a population of 2.5×10^8)	50 000	40 000
Number of leukaemia cases (in ditto)	15 000	26 000

Thus on the score of radiation injury to the world population, a clean hydrogen bomb operating by the reaction of deuterium and tritium cannot be considered less dangerous than an ordinary atomic bomb.

61

10456 COMPARATIVE PERFORMANCE OF GRIDS IN RELATION TO THEIR STATED RATIO.
R.W.Stanford, R.D.Moore and T.H.Hills.
Brit. J. Radiol., Vol. 32, 106-13 (Feb., 1959).

It is suggested that the performance of diagnostic X-ray grids could be assessed by measuring the added photographic density produced by the scattered radiation which penetrates the grid (at a total density of 1.5) and also the relative exposures required to produce the density of 1.5 both with and without the grid. For a series of grids these criteria agree fairly well with observations of radiographs taken with them. The customary "grid ratio" is shown to be only of limited value for comparison purposes. J.R.Mallard

61 : 539.1.07

AUTOMATIC CONSTANT SIGNAL PLOTTER IN MEDICAL LABORATORIES. See Abstr. 9242

61 : 539.16

10457 ON THE DANGER FROM RADIOACTIVITY ARISING FROM AN UNBROKEN SERIES OF ATOMIC BOMB TRIALS. O.I.Leipunskii.
J. nuclear Energy, Vol. 9, No. 1-4, 97-106 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 63 (1958).

Calculations are made of the consequences of radioactive fall-out, assumed to be dispersed over the earth's surface, from an uninterrupted series of trial atomic explosions at the rate of 11 megatons-equivalent of TNT per year. It is shown that by the end of the century the concentration of Sr^{90} in the vertebrae of a large section of the world's population may have exceeded the present official tolerance figure. Each year of continued tests will give rise to another 44 000 genetically handicapped individuals with hereditary ailments, and to 29 000 cases of leukaemia.

Vision

612.8

10458 MONOCULAR "RIVALRY" BETWEEN STABILIZED AND UNSTABILIZED RETINAL IMAGES. D.M.Mackay.
Nature (London), Vol. 185, 834 (March 19, 1960).

It is shown that the fading of stabilized retinal images may be due to factors other than retinal adaptation. R.A.Weale

TECHNIQUE . MATERIALS

62

10459 **A PISTON PIEZOMETER WITH QUASI-HYDROSTATIC SUPPORT FOR PRESSURES UP TO 100 000 kg/cm².**

Yu.N.Ryabinin and L.D.Livshits.
Zh. tekh. Fiz., Vol. 29, No. 9, 1167-70 (Sept., 1959). In Russian.
English translation in: Soviet Physics – Technical Physics (New York), Vol. 4, No. 9, 1065-67 (March, 1960).

Only brief details of the apparatus are given. No new principles are involved. E.G.Knowles

62 : 533.5

ATOMICALLY CLEAN METAL SURFACES. See Abstr. 8726

620.1

10460 **CHOICE OF FREQUENCY FOR EDDY-CURRENT TUBE TESTING.** F.R.Bareham.
Brit. J. appl. Phys., Vol. 11, No. 6, 218-22 (June, 1960).

Eddy-current testing can be used to detect faults in metal tubes by passing the tube through a pair of short solenoidal coils which are energized by an alternating current. The decrease in density of the induced eddy-currents from the outer surface is determined by the frequency of the energizing current and by the electrical properties and dimensions of the tube. Since the eddy-currents flow in a circumferential direction, their distribution is not, as often assumed in the past, the same as when current flows in the direction of the axis. The distribution of eddy-currents flowing circumferentially is given in general terms for non-magnetic tubes and the results can be used in conjunction with a nomogram to determine suitable frequencies for many practical applications.

621.9

10461 **ON THE PROBLEM OF THE ANALYTICAL METHOD IN DETERMINATION OF THE CUTTING TEMPERATURE.**

N.V.Talantov.
Zh. tekh. Fiz., Vol. 29, No. 1, 141-5 (Jan., 1959). In Russian.
English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 1, 123-6 (Jan., 1959).

The paper gives the derivation of an expression for calculating the chip—tool interface temperature during machining operations. Comparison is given with temperatures measured by the method of "natural" thermocouples. E.G.Knowles

669

10462 **THE EFFECT OF OXYGEN, CARBON AND NITROGEN ON THE PROPERTIES OF SINTERED THORIUM.**

M.D.Smith and R.W.K.Honeycombe.
J. nuclear Mater., Vol. 1, No. 4, 345-55 (Dec., 1959).

A study has been made of the mechanical properties and microstructures of alloys of thorium with oxygen, nitrogen and carbon prepared by sintering followed by cold working and annealing. It is shown that the properties obtained are comparable, and in some cases superior,to those obtained from arc-melted alloys. Unlike oxygen and nitrogen, small concentrations of carbon increase the strength of thorium markedly. A re-determination of the solid solubility of carbon in thorium has enabled a closer correlation of the observed strengthening with carbon solubility to be made. Metallographic observations have been made on the occurrence of thoria, thorium nitride ThN and thorium carbide ThC in the various alloys.

669 : 539.23

10463 **INTERMETALLIC REACTIONS AND AGEING EFFECTS IN THIN FILMS.** C.Weaver and R.M.Hill.
Advances in Phys., Vol. 8, 375-437 (Oct., 1959).

This is a sixty-page survey of the application of thin film methods to metallurgy. The principal technique in the past has been electron diffraction as this gives the most direct evidence relating to structure. X-ray methods have not been so successful because of lack of sensitivity. The disadvantage of thin film methods is that conclusions drawn do not necessarily apply to bulk specimens. However the study of age-hardening by electrical resistivity measurements appears promising. An extensive bibliography is attached. T.Mulvey

LIST OF JOURNALS

Astron. J.
Astronomical Journal — Publisher changed to: American Institute of Physics, 335 East 45th Street, New York 17, N.Y., with Vol. 65, No. 1, February, 1960.

Bull. Soc. Roy. Belge Elect.
Bulletin de la Société Royale Belge des Electriciens (Formerly: Bulletin de la Societe Belge des Electriciens [Bull. Soc. Belge Elect.]) — 1 Place du Trône, Brussels.

Feinwerktechnik
Feinwerktechnik — Article reprinted in: Entwicklungsberichte der Siemens und Halske Aktiengesellschaft [Entwicklungsber. Siemens und Halske].

Glass Technol.
Glass Technology — Society of Glass Technology, Thornton, Hallam Gate Road, Sheffield 10.

J. Assoc. Appl. Physicists (India)
Journal of Association of Applied Physicists — 92 Upper Circular Road, Calcutta 9.

Przeglad telekomun.
Przeglad Telekomunikacyjny — Subscription address: Centrali Kolportazu Prasy i Wydawnictw "Ruch", ul. Srebrna 12, Warsaw.

Rep. Govt Industr. Res. Inst.
Reports of the Government Industrial Research Institute, Nagoya — Hirate-machi, Kita-ku, Nagoya.

Rev. A
Revue A. — Presses Académiques Européennes, 98 chaussée de Charleroi, Brussels 6.

CHANGE OF TITLE

B.T.H. Activ.
B.T.H. Activities — Replaced after Vol. 30, No. 7, 1960, by: A.E.I. Engineering Review [A.E.I. Engng Rev.].

Bull. Soc. Belge Elect.
Bulletin de la Société Belge des Electriciens — Title changed to: Bulletin de la Société Royale Belge des Electriciens [Bull. Soc. Roy. Belge Elect.] with issue dated October-December, 1959.

Metropolitan-Vickers Gaz.
Metropolitan-Vickers Gazette — Replaced after No. 486, 1960, by: A.E.I. Engineering Review [A.E.I. Engng Rev.].

Siemens Edison Swan J.
Siemens Edison Swan Journal — Replaced after Vol. 1, No. 3, 1959, by: A.E.I. Engineering Review [A.E.I. Engng Rev.].

NEW JOURNALS

A.E.I. Engng Rev.
A.E.I. Engineering Review — Associated Electrical Industries Ltd., 33 Grosvenor Place, S.W.1. Vol. 1, No. 1 dated May, 1960. Replaces: B.T.H. Activities [B.T.H. Activ.] Metropolitan-Vickers Gazette [Metropolitan-Vickers Gaz.] Siemens Edison Swan Journal [Siemens Edison Swan J.] and Distribution of Electricity.

Przeglad Elektron.
Przeglad Elektroniki — Subscription address: Przedsiebiorstwo Kolportazu Wydawnictw Zagranicznych "Ruch", ul. Wilcza 46, Warsaw. Vol. 1, No. 1 dated 1960.

Abstracts of articles from the following journals have been reprinted, with kind permission, from "Mathematical Reviews", and the addresses are not available at present.

Acad. R.P. Romine Bul. St. Sect. Sti. Mat. Fiz.
Academia Republicii Populare Romine Buletin Stiintific. Sectiunea de Stiinte Matematice si Fizice.

Arch. Mech. Stos.
Archiwum Mechaniki Stosowanej.

Arch. Rational Mech. Anal.
Archive for Rational Mechanics and Analysis.

Bull. Soc. Math. France
Bulletin de la Société Mathématique de France.

Com. Acad. R.P. Romine
Comunicările Academiei Republicii Populare Romîne.

J. Aero. Sci.
Journal of the Aeronautical Sciences.

J. Aero/Space Sci.
Journal of the Aero/Space Sciences.

J. Math. Mech.
Journal of Mathematics and Mechanics.

J. Reine Angew. Math.
Journal für die Reine und Angewandte Mathematik.

Rev. Acad. Ci. Madrid
Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid.

Tensor (N.S.)
Tensor. New Series.

Teor. Veroyatnost. i Primenen.
Teoriya Veroyatnostei i ee Primeneniya.

Voprosy Kosmog.
Voprosy Kosmogonii.

ERRATA

Abstr. 13776 (1959) line 3: for "Vol. 149" read "Vol. 14a".

Author Index (1959) p. 1390, column 2: after Fritschen,L.J. and van Wijk,W.R., for "2891" read "12891".

Abstr. 3540 (1960) line 11: for "sulphide" read "sulphate".

Abstr. 5527 (1960) line 8: for "ΔG" read "ΔQ".

Abstr. 5533 (1960) line 3: for "Chou Guan-Chao" read "Chzhou Guan-Chzhao".

Abstr. 6113 (1960) line 2: for "BULK OF GERMANIUM" read "BULK IN GERMANIUM".

Abstr. 6239 (1960) line 2: for "M.Paulis" read "M.Paulus".

Abstr. 6907 (1960) line 2: for "G.Toraldi di Francia" read "G.Toraldo di Francia".

Abstr. 7288 (1960) line 3: for "Chou Guan-chao" read "Chzhou Guan-Chzhao".

Abstr. 7319 (1960) line 3: for "Chou Kuang-Chou" read "Chou Kuang-Chao".

Abstr. 7993 (1960) line 3: after (1958) insert "In Russian".

Abstr. 8264 (1960) line 6: for "absorption" read "adsorption".

Abstr. 8853 (1960) line 3: for "Faizulov" read "Faizullov".

Abstr. 9168 (1960) line 3: for "Yu.N.Vandakurov" read "Yu.V.Vandakurov".

Abstr. 9169 (1960) line 3: for "K.M.Stanyukovich" read "K.P.Stanyukovich".

Abstr. 9335 (1960) line 3: for "Vol. 15" read "Vol. 45".

Abstr. 9634 (1960) line 3: for "B.G.Neudachin" read "V.G.Neudachin".

May (1960) p. 638: Abstract serial number "5613" should read "6513".

May (1960), author index: after "Vul,B.M., 6099" insert "6100"; for "Zavaritskaya,E.I., 6099" read "Zavaritskaya,E.I., 6100".

AUTHOR INDEX

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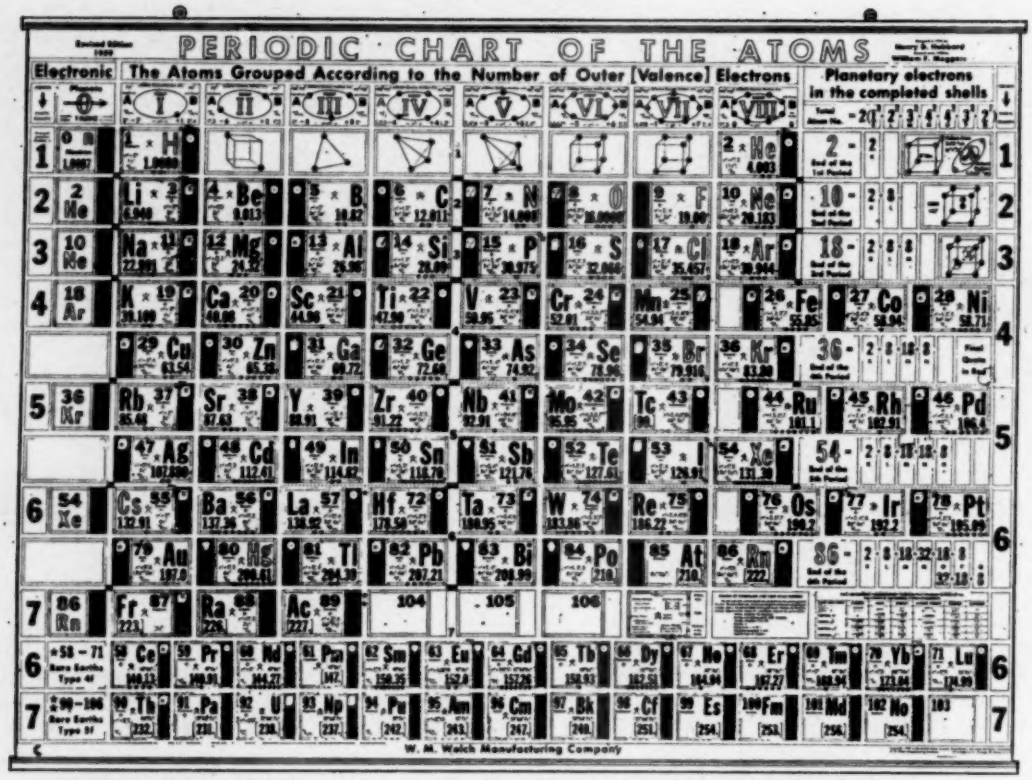

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